

THE RAVENELIAS OF THE UNITED STATES AND MEXICO.

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(WITH PLATES II AND III)

THE writer originally intended to include in this paper only the Texan species, but as the study advanced it became evident that many Mexican species would be found in Texas, probably all of them when the fungal flora of the extreme southern and southwestern section of the state is collected and studied; while in the eastern and northeastern counties the species of the southern Atlantic states would probably be found; so it was thought best to include in the present paper all known Ravenelias from the United States and Mexico.

The genus seems to be mainly tropical and subtropical, only two species being found above latitude 38° , viz., *R. opaca* and *R. epiphylla*, the latter being the most widely distributed subtropical species known, extending as far north as New York, westward to the Mississippi, and southward to Florida. The known species are distributed as follows: United States 11, Mexico 15, Central and South America 21, West Indies 1, South Africa 12, Ceylon 5, and Japan 1.

The Ravenelias are among the most natural and marked groups of all the Uredineae. So far as known they are confined entirely to the Leguminosae as to host, with two exceptions, viz., *R. appendiculata* and *R. pygmaea*, found on *Phyllanthus*. Most of the species on the Leguminosae are parasitic on the two suborders Caesalpinieae and Mimoseae.

The genus *Ravenelia* was founded by Berkeley, with *R. indica* and *R. glandulosa* as its first species. At that time, and for some years afterwards, the exact status of the genus was not known, as the general morphology of the plant and the germination of the teleutospores had not been studied. Later Parker¹ studied

¹On the morphology of *Ravenelia glanduliformis*. Proc. Amer. Acad. 22: 205-217. 1886.

the morphology of one species, and Cunningham² worked on the life histories of two species. Duggar³ investigated the germination of the teleutospores. In 1894 Dietel⁴ published his excellent monograph of the genus. This included all the *Ravenelias* then known and gave a brief résumé of previous work, together with a rather full discussion of the characters of the various species, followed by systematic descriptions and plates to illustrate the various species. Since then many new species (about fifteen) have been described by various authors, most of them from the Americas. Much light was thrown on the general life-history, morphology, etc., by these investigations, and the true status of the genus was fully determined, all of its characters undoubtedly placing it with the Uredineae. Much careful work yet remains to be done, as all that is known of most of the species is a brief systematic description of the dried plant.

The writer is under many obligations for specimens, etc., to Mr. E. W. D. Holway, Dr. P. Sydow, Dr. P. Hennings, Dr. P. Dietel, Dr. W. G. Farlow, Professor E. O. Wooton, Mr. S. B. Parish, Mr. Elam Bartholomew, Dr. D. Griffiths, Shaw Botanical Gardens, New York Botanical Gardens, Dr. J. C. Arthur, and the U. S. Dept. of Agriculture; also to Professor George F. Atkinson for his aid and advice throughout the prosecution of this work.

All drawings were made with the aid of an Abbé camera lucida from material that had been boiled in lactic acid to restore the spores to their natural size and shape and bring out details that would not otherwise be noted. In some instances only a small quantity of material of a given species was available. In such a case the question arose how best to utilize this to show all the essential characters. The method pursued was first to mount a bit in distilled water and allow the water to evaporate. In this condition all the minute surface markings of the spores are more plainly seen; but this preparation would not show the germ pores and would usually burst the cysts. Hence a second mount was

² Notes on the life history of *Ravenelia sessilis* B. and *Ravenelia stictica* B. and Br. Scientific Mem. of Medical Officers of the Army of India, 1889.

³ Germination of the teleutospores of *Ravenelia cassiaecola*. BOT. GAZ. 17: 144-148. 1892.

⁴ Die Gattung *Ravenelia*. Hedwigia 33: 22-69, 367-371. 1894.

found necessary, prepared as follows: A mixture of equal parts of 100 per cent. glycerin and 80 per cent. alcohol was made, and a glass slide was used on which a cell of white zinc had been made. It was found necessary to make the cells two layers thick in order to get the proper depth, putting on as much zinc each time as would stay without spreading too much; an interval of one to two hours between the putting on of the two layers is required. The slide was laid aside until the cell became dry and hard. In the center of this cell a scant drop of the glycerin and alcohol mixture was put; into this the spores, etc., were put; then a drop of 50 per cent. lactic acid was added and the slide heated over an alcohol lamp until the liquid came to a boil. In some cases it is necessary to boil it for a short time to make the germ pores show plainly. Care had to be taken not to boil so long as to burst the cysts, and yet to boil until the germ pores were visible; usually bringing the mixture to a boil accomplished the desired result. The mixture of alcohol and glycerin as given above prevents the bursting of the cysts, which usually happens in a water mount, while the acid makes the germ pores visible. After the preparation had cooled a cover glass was put on and sealed with white zinc. This makes a neat permanent mount, ready for instant use at any time, and shows practically all the desired details.

To ascertain whether the sori are subepidermal or subcuticular, microtome sections should be made. Most of the specimens will be dry and must be softened before they can be imbedded. A good method for softening the tissues is to place them in a mixture of equal parts of 65 per cent. alcohol and 100 per cent. glycerin; then heat this in the paraffin oven for twenty-four to forty-eight hours, at the end of which time the tissues will usually be soft and pliable; then wash in 65 per cent. alcohol for six hours; then run up and into paraffin in the usual manner. Bismarck brown or methyl blue makes a good stain for such preparations where the main object is to see the position of the sori. The cysts would often come through the entire process and show up beautifully in the Canada balsam mount.

The boiling in lactic acid is desirable for several reasons;

in addition to its bringing out the germ pores it swells the spores to their normal shape and size; drives out the air and makes them more transparent; by scattering the spores makes visible any uredospores or paraphyses that would otherwise be overlooked. By this means the uredospores of several species were found, of which hitherto only the teleutospore stage had been known.

Sometimes it is necessary to make a fourth preparation to see whether the teleutospores are all one-celled, or some two-celled; this will often be shown in the lactic acid mount where some of the teleutospore heads will be broken up; but in case this does not happen, it becomes necessary to macerate the material for twelve to twenty-four hours in a weak solution of caustic potash or even to boil it in this solution for a few minutes, when by pressure on the cover glass the heads will fall apart and the interior structure can be seen.

If permanent mounts are not desired, the cell feature can be omitted and the mount made on the slide direct. Usually free-hand sections of the softened specimen will show the position of the sori in the leaf, and this can be done where a sufficient quantity of material is available; but where only a bit, and that of a type or rare species is at hand, it is best to use the microtome.

A study of the life history of the various species has not been attempted in this article. One species (*R. Holwayi*) was found whose aecidial stage differs from the type in that it is without a pseudoperidium. This species is placed in a new genus (*Neoravenelia*), distinguished from *Ravenelia* by its caeoma type of aecidia. The deep-seated character of the aecidiosori of this species is in marked contrast to the very shallow sori of the uredospores and teleutospores, which are usually between the cuticle and the epidermal cells or just beneath the epidermis. As the life history of the various species becomes better known, others in all probability will be found to have a caeoma type of aecidia, and will have to be transferred to *Neoravenelia*.

The genus naturally falls into two sections, according to the number of cells in the teleutospores. The first section (*Rave-*

nelia) includes all species in which all the teleutospores in a head are one-celled; the second section (*Pleoravenelia*) includes all species in which the inner teleutospores of a head are two-celled. As a matter of convenience it seems desirable to recognize these two sections as distinct genera.

KEY TO GENERA.

- All teleutospores in a head one-celled; aecidia when present with a well developed pseudoperidium - - - - - *Ravenelia*
 Inner teleutospores in a head two-celled; aecidia as in *Ravenelia* - - - - - *Pleoravenelia*
 All teleutospores in a head one-celled; aecidia without a pseudoperidium - - - - - *Neoravenelia*

RAVENELIA Berk.

BERKLEY, Gardeners' Chronicle 10: 132. 1853.

PARKER, The Morphology of *Ravenelia glanduliformis*. Proc. Amer. Acad. 22: 205-217. 1886.

COOKE, The genus *Ravenelia*. Jour. Roy. Micr. Soc. 3: 384. 1880.

DUGGAR, Germination of the teleutospores of *Ravenelia cassiaecola*. Bot. GAZ. 17: 144-148. 1892.

DIETEL, Die Gattung *Ravenelia*. Hedwigia 33: 22-69, 367-371. 1894; Engler and Prantl. Nat. Pflanz. 11: 73-75. 1897-1901.

Spermogonia formed between the cuticle and the epidermal cells, hemispherical. Aecidia with a well developed pseudoperidium. Uredospores borne singly on short stalks, with germ pores few or many; paraphyses usually present in the uredosori. Teleutospores united into cushion-like heads, formed of several or many cells; all teleutospores in a head one-celled; attached to the under side of the heads are several to many hyaline cells or cysts; pedicel of the head composed of several hyphae, which are either united into a compound stipe or separate.

KEY TO SPECIES.

- | | | |
|--|-----------|---|
| 1. Teleutospore heads smooth | - - - - - | 2 |
| Teleutospore heads rough, spinous, warty, etc. | - - - - - | 8 |
| 2. Uredospore germ pores many, scattered | - - - - - | 3 |
| Uredospore germ pores equatorial in one row | - - - - - | 5 |
| Uredospore germ pores in two rows | - - - - - | 6 |
| Uredospores unknown | - - - - - | 7 |
| 3. Sori sub-cuticular; cysts pendent | - - - - - | 4 |

4. Cysts peripheral; paraphyses many, clavate-capitate - - - *R. texana*
 Cysts beneath entire head; paraphyses few, hypha-like - *R. Longiana*
 Cysts beneath entire head; paraphyses none; pedicel stout,
 fulvous - - - - - *R. indica*
5. Sori sub-epidermal germ pores 4; cysts pendent many "*R. Holwayi*."
6. Uredospores brown, with a row of 4 germ pores on either side
 of equator - - - - - *R. siliquae*
 Uredospores fulvous, base hyaline to semi-hyaline, 4 germ pores
 in equator and 4 in a row near base - - - - *R. versatilis*
7. Sori sub-cuticular; heads chestnut brown - - - *R. Farlowiana*
 Sori sub-epidermal; heads black, opaque - - - *R. opaca*
8. Uredospore germ pores many, scattered - - - - - 9
 Uredospore germ pores 4, equatorial - - - - - 12
 Uredospore germ pores 8, in two rows on either side of
 equator - - - - - *R. siliquae*
9. Sori sub-cuticular; cysts peripheral - - - - - 10
 Sori sub-cuticular; cysts not peripheral - - - - - 11
 Sori sub-epidermal; cysts coherent; III heads densely warty.
R. verrucosa
10. Cysts pendent; heads minutely verrucose - - - *R. expansa*
 Cysts pendent; heads several with long (5-8 μ) brown papillae
 on each spore - - - - - *R. mimosae-sensitivae*
11. Stipe long, persistent, fulvous; papillae few, scattered - *R. cassiaecola*
 Stipe short, hyaline; papillae few, scattered - - - *R. mesillana*
 Stipe short, hyaline; III heads with several short papillae to
 each spore - - - - - *R. fragrans*
 Stipe short, hyaline; III with one (2-7 μ) papilla to each spore.
R. spinulosa
12. Sori sub-epidermal; each spore of III heads armed with a stout
 appendage which is branched at apex - - - *R. appendiculata*
 Sori sub-epidermal; each spore of III heads armed with a
 curved hyaline spine (1-6 μ) - - - - - *R. arizonicā*
 Sori sub-cuticular; cysts not pendent, peripheral; uredospores
 18-20 by 22-25 μ - - - - - *R. mexicana*
 Sori sub-cuticular; cysts pendent, peripheral; uredospores
 15-18 by 35-40 μ - - - - - *R. leucaenae*

RAVENELIA TEXANA Ell. and Galw., Jour. Mycol. 6:2. 83. 1890;
 Jennings, Bull. Tex. Agr. Exp. Sta. 9: 1890.—Fig. 1.

Ravenelia texensis Dietel, Hedwigia 34:42-43, 63-64. 1895; Saccardo
 Syll. Fung. 11: 210. 1895.

Sori breaking forth between the cuticle and the epidermal
 cells on both sides of the leaves, and sparingly on the leaf stems,

⁵ See *Neoravenelia Holwayi*.

small. Uredosori not present in material examined; uredospores oval to spheroid, light brown, spinulose, 13–20 by 16–20 μ , germ pores many, scattered; paraphyses hyaline to fulvous, clavate to capitate, 50–70 μ long, 10–20 μ thick; heads fulvous. Teleutospore heads dark brown, smooth, irregularly orbicular, 60–70 by 20–35 μ thick; 5–6 spores in cross-section, each 16–20 by 30 μ , tops dark brown; cysts oblong to ovate, hyaline, pendent, peripheral, swelling and bursting in water; pedicel hyaline, short.

On *Desmanthus* or *Cassia*: College Station, Texas, 1889. Leg. *Brunk* and *Jennings*.

RAVENELIA LONGIANA Syd., *Hedwigia* 40: 128. 1901.—*Fig. 2.*

Sori breaking forth between the cuticle and the epidermal cells; on both sides of the leaves. Uredosori cinnamon-brown, orbicular, 0.5–1^{mm} in diameter, often confluent over wide areas, mainly on the under side of the leaves; uredospores obovate, oval or spheroid, spinulose, light brown, 20–33 by 23–26 μ ; germ pores many, scattered; paraphyses present in the uredosori; few, semi-hyaline, hypha-like, walls much thickened. Teleutosori large, black, orbicular, 1–2^{mm} in diameter, on both sides of the leaves; teleutospore heads chestnut-brown, smooth, irregularly orbicular, 75–90 by 25–33 μ thick; 6–8 spores in cross section; cysts hyaline, spheroid to pyriform, beneath entire head, crowded, diameter about 16 μ ; pedicel hyaline, compound, short.

On *Cassia Roemeriana*: Austin, Texas, Nov. 15, 1897 (type material for III spores); Aug. 24, 1901, no. 1019 (type for II sori). The type material for this species had no uredosori on the leaves, but a few uredospores were intermixed with the teleutospores. In August 1901, the writer collected the uredosori for the first time; the under side of the leaves of the host was nearly covered with the sori, while the upper surface was comparatively free.

RAVENELIA INDICA Berkeley, *Gard. Chron.* 10: 132. 1853. Cooke, *Jour. Roy. Micr. Soc.* 3: 385. 1889; Saccardo, *Syll. Fung.* 7: 772–773. 1888; Dietel, *Hedwigia*, 33: 51–52, 60. 1894; Holway, *BOT. GAZ.* 31: 336. 1901.—*Fig. 4.*

Sori breaking forth between the cuticle and the epidermal cells. Uredosori on both sides of the leaves, often irregularly grouped around a central sorus, cinnamon-brown; uredospores ovate to globose, spinulose, pale yellow, 13–17 by 17–20 μ ; germ pores many, scattered; paraphyses none. Teleutosori

on the leaf stems and on the branches, forming somewhat swollen places of 4–6^{mm} in diameter, chestnut-brown; teleutospore heads orbicular, smooth, light brown, 60–85 by 33–40 μ thick; 4–6 spores in cross section, each 16–22 μ broad; cysts firm, persistent, flask-shaped, hyaline, 15–18 μ in diameter, hanging in a cluster around the pedicel, beneath the entire head; pedicel stout, persistent, compound, fulvous, 95–150 by 20–25 μ .

On *Cassia absus*: Tequila, Mexico, Sept. 29, 1893. Leg. *Pringle*.

Ravenelia siliquae, n. sp.—*Fig. 7*.

Sori breaking forth between the cuticle and the epidermal cells. Uredosori orbicular, large, 1–4^{mm} in diameter, cinnamon-brown, prominently surrounded by the ruptured cuticle, scattered or more or less confluent; uredospores fulvous, epispore densely verrucose, oblong-oval to ovate-fusiform, 13–17 by 20–33 μ , usual size 16 by 30 μ ; germ pores 8, in two rows of 4 each, one row on either side of the equatorial zone; paraphyses very rare, hyaline or slightly fulvous at the apex, clavate, 43 by 7 μ .

On pods of *Acacia farnesiana*: Etna, Oaxaca, Mexico, Oct. 25, 1899, no. 3841, *Holway*. Mr. Holway writes that this species was found only on the pods, the leaves being free from the rust. The peculiar position of the germ pores of the uredospores is such a marked character that the writer did not hesitate to establish a new species, as no other known *Ravenelia* has this character. No teleutospores were present in the material examined.

RAVENELIA VERSATILIS (Peck) Dietel, *Hedwigia* 33: 38–42, 64, 368–369. 1894; Saccardo, *Syll. Fung.* 11: 210–211. 1895.—*Fig. 3*.

Uromyces versatilis Peck, *BOT. GAZ.* 7: 56. 1882; Saccardo, *Syll. Fung.* 7: 582–583. 1888.

Ravenelia decidua (Pk.) Holway, Dietel in *Hedwigia* 33: 370. 1894; Saccardo, *Syll. Fung.* 11: 211. 1895.

Uromyces deciduus Peck, *Reg. Rept.* 45: 25. 1891.

Sori breaking forth between the cuticle and the epidermal cells, on both sides of the leaves. Uredosori small, ochreous, thickly covering the leaves and often the leaf stems and branches; upper half of spores brown and somewhat thickened at apex, with spinules less prominent than those of the lower part; lower half fulvous to sub-hyaline, rugose-echinulate; elliptical to ellip-

tical-ovate, 27-33 by 14-17 μ ; germ pores 8 in two rows, one row of 4 germ pores in the equator, the other row near the base of the spore; paraphyses numerous, light yellow to semi-hyaline, clavate to capitate; pedicel hyaline, 50-60 μ long; heads 13-20 μ in diameter, very variable in shape. Teleutosori dark brown, on both sides of the leaves, small, 1^{mm} or less in diameter, oval to orbicular; teleutospore heads brown, usually smooth, but margin of some of the fully mature spores sometimes faintly verrucose, orbicular to oval, 83-100 μ in diameter; 6-8 spores in cross section, marginal spores 10-12, spores 40-45 by 16-18 μ , with apex brown for 4-5 μ ; cysts hyaline, peripheral, oblong-ovate, few, 24-30 μ , swelling and finally bursting in water; pedicel compound, short, slightly fulvous, deciduous.

On *Acacia Greggii*: Gillespie co., Texas, Jermy 557 (U. S. Dept. Agr.); Tucson, Arizona, Aug. 1892, J. W. Toumey; San Bernardino, Cal., June 4, 1894, Parish 3377; Mescal mts., Arizona, May 24, 1890, M. E. Jones.

This is one of the very widely distributed *Ravenelias* as the above citations show. It is also a very marked and easily recognized species, as its uredospores are very characteristic, having two rows of germ pores, one in the equator and the other near the base of the spore, the lower half usually being hyaline or nearly so, and when boiled in lactic acid the lower half swells up and the outer part of the epispore appears gelatinous, giving the entire spore somewhat the appearance of an acorn in its cup, the upper half representing the acorn and the lower the cup.

In all the material examined except the Texan specimen, only uredosori were present, with an occasional teleutospore; the Texan specimen on the other hand was teleutospore material with only a few uredospores intermixed. A sufficient number were present, however, to fully identify the plant and to show all the peculiar characters of the typical uredospores of *R. versatilis*. The Texan plant was reported on *Acacia filicina* Willd., which proved on comparison with authentic specimens to be not *A. filicina* but *A. Greggii*. This comparison was made by the writer at the Missouri Botanic Garden, St. Louis, with Jermy's original collection from near San Antonio, Texas. Even the plant in the herbarium was infected with the rust. The species heretofore called *R. decidua* (Peck) Holw. proved on careful comparison to be in every respect identical with *R. versatilis* (Pk.) Diet. It is reported on all specimens examined as being on *Prosopis pubescens*, but a comparison of authentic specimens of this species with the host proved the previous determinations to be erroneous, and the host to be *Acacia Greggii*. Type material of *R. decidua* was examined and compared with authentic specimens of *R. versatilis*, with the above results both as to hosts and parasites.

RAVENELIA FARLOWIANA Dietel, Hedwigia 33: 369. 1894; Saccardo, Syll. Fung. 11: 211. 1895.—*Fig. 6.*

Sori breaking forth between the cuticle and the epidermal cells, mainly on the upper surface of the leaves and sparingly on the leaf stems. Uredosori and uredospores not present. Teleutosori orbicular, large, 4–5^{mm} in diameter, dark brown, when old with heads densely compacted into a crust-like layer, when young with a central sorus surrounded by a circle of spores, usually solitary; paraphyses none. Spermogonia present, chestnut-brown, about 100 μ in diameter, subcuticular. Teleutospore heads very irregular in shape and in size, chestnut-brown, usually smooth but an occasional head with small warts on the margin, 50–106 by 40 μ thick, usual size 75–95 μ ; spores 5–8 in cross section, very irregular in shape and size; cysts hyaline, peripheral, oblong ovate, with bases closely appressed to under side of heads, swelling and bursting in water; pedicel short, hyaline, deciduous.

On *Acacia anisophylla* and *A. crassifolia*: Mexico, Pringle. Specimens examined from herb. of Dr. Farlow.

RAVENELIA OPACA (Seym. and Earle) Dietel, Hedwigia 34: 291. 815; Saccardo, Syll. Fung. 14: 363. 1899.—*Fig. 5.*

Ravenelia indica forma *opaca* Seym. and Earle, Econ. Fungi no. 203.

Sori subepidermal, scattered or solitary on both sides of the leaves but mainly on the upper surfaces. Uredosori and uredospores not present. Teleutosori black, shining, large, 1–2^{mm} in diameter; teleutospore heads black, opaque, orbicular, smooth, 80–120 μ in diameter; 5–6 spores in cross section, spores 20–26 by 33 μ , apex intensely black-brown for 7–10 μ ; cysts globose, hyaline, pendent around the pedicel, swelling and bursting in water. Pedicel long, compound hyaline.

On *Gleditschia triacanthus*: Clear Creek, Union co., Ill., F. S. Earle, Aug. 13, 1890.

RAVENELIA VERRUCOSA Cke. and Ell., Jour. Mycol. 3: 83. 1887; Grevillea 15: 112. 1887; Saccardo, Syll. Fung. 7: 772. 1888; Dietel, Hedwigia 33: 41–42, 66. 1894.—*Fig. 9.*

Sori subepidermal, on both sides of the leaves but mainly on the upper surface. Uredospores intermixed with the teleutospores, brown, spinulose, oval to globose, 15–18 by 17–20 μ ; germ pores many, scattered; paraphyses many, cylindrical, hypha-like,

chestnut-brown, 45–60 by 7μ , bases hyaline. Teleutosori black, 0.5–1^{mm} in diameter, more or less covering the surface of the leaves; teleutospore heads chestnut-brown, opaque, irregularly orbicular, 75–100 by $35\text{--}40\mu$; 4–8 spores in cross section, spores with many short hyaline papillae to each spore; cysts coherent and decurrent into the hyaline pedicel, peripheral; pedicel short, hyaline, deciduous.

On *Leucaena lanceolata*: Watson no. 6, Dr. E. Palmer, 1886. The host was determined by Dr. J. N. Rose, U. S. National Museum.

RAVENELIA EXPANSA Diet. and Holw., BOT. GAZ. 23: 35. 1887; Saccardo, Syll. Fung. 14: 364. 1899.—Fig. 10.

Sori breaking forth between the cuticle and the epidermal cells, on both sides of the leaves, in large pallid spots which are specially prominent on the under side of the leaves. Uredosori rare, ochraceous, small; uredospores fulvous, spinulose, globose to subglobose, 17–20 by 20μ ; germ pores many, scattered; paraphyses clavate, heads fulvous, 13–16 by 26μ ; pedicel hyaline, about length of head or often shorter. Mature teleutosori chestnut-brown, large, up to 2^{mm} in diameter, surrounded by the ruptured cuticle; teleutospore heads orbicular, verrucose, light brown, 70–90 by $35\text{--}40\mu$ thick; 5–7 spores in cross section, each crowned with several short, hyaline warts; cysts hyaline, pendent, oblong ovate, peripheral, 7–10, easily swelling and bursting in water; pedicel hyaline, short, compound, deciduous.

On *Acacia tequilina* Wats.: Guadalajara, Mexico, Oct. 13, 1896 (type), Holway.

RAVENELIA MIMOSAE-SENSITIVAE P. Henn., Hedwigia 35: 246. 1896.—Fig. 11.

Sori breaking forth between the cuticle and the epidermis, on both sides of the leaves, thickly distributed over the leaf surface. Uredosori cinnamon color, often in a circle around a central sorus; uredospores light brown, densely spinulose, ovate to spheroid, 20–22 by 23μ ; germ pores many, scattered; paraphyses broadly clavate to subcapitate, 13–20 by $50\text{--}60\mu$; heads fulvous, pedicel and base of head hyaline. Teleutosori small, scattered, black; teleutospore heads orbicular to oval, black-brown, 65–80 by 33μ thick; spores 4–6 in cross section, each crowned with several long ($5\text{--}8\mu$) brown papillae, apex somewhat

thickened for $5-6\ \mu$, spores $33-35$ by $16-20\ \mu$; cysts hyaline, ovate to spheroid, about $20\ \mu$ in diameter, peripheral, $6-10$; pedicel short, hyaline, deciduous.

On *Mimosa albida*: Cuernavaca, Mexico, Sept. 24 and 29, 1899, *Holway*. Through the kindness of Dr. Hennings the writer was enabled to compare the Mexican form with type material from South America, and the two proved to be the same species.

RAVENELIA CASSIAECOLA Atkinson, BOT. GAZ. 16: 313. 1891; Dietel, Hedwigia 33: 50-51, 60-61. 1894; Duggar, BOT. GAZ. 17: 144-148. 1892; Saccardo, Syll. Fung. 11: 212. 1895; Atkinson, Bull. Cornell Univ. Science 3: 20. 1897; Underwood and Earle, Bull. 80, Ala. Agr. Exp. Sta. 217-218. 1897.—*Fig. 12.*

Sori breaking forth between the cuticle and the epidermal cells. Uredosori mainly on the leaves, on both sides, small, $1\ \text{mm}$ or less, cinnamon colored; uredospores broadly ovate to globose, fulvous or hyaline, minutely echinulate, $14-17$ by $16-18\ \mu$; germ pores many, scattered; paraphyses none. Teleutosori on the stems, black-brown, large, often confluent for several centimeters; teleutospore heads fulvous to chestnut-brown, $30-100\ \mu$, usual size $60-80\ \mu$; 4-6 spores in a cross section, usually with a short hyaline point to each spore; cysts hyaline, firm, globose, $14-18\ \mu$ in diameter, pendent, beneath the entire head; pedicel compound, persistent, fulvous, $60-110\ \mu$ long.

On *Cassia nictitans*: Auburn, Ala., 1891, *Atkinson*, also 1893, *Duggar*; Starkville, Miss., Sept. 19, 1892, *Ellis* and *Everhart*, N. A. F. 2d series, no. 2880, also Sept. 19, 1891, *Seymour* and *Earle*, E. C. Fung. Suppl. no. 325.

RAVENELIA MESILLANA Ell. and Barth., Bull. Torr. Bot. Club 25: 508. 1898; Saccardo, Syll. Fung. 16: 323. 1902.—*Fig. 13.*

Sori breaking forth between the cuticle and the epidermal cells, mainly on the upper surface of the leaves. Uredosori not present in material examined, but uredospores intermixed with teleutospores; uredospores light brown, broadly oval to globose, spinulose, $20-23$ by $17-20\ \mu$; germ pores many, scattered; paraphyses none. Teleutosori orbicular, crowded and often confluent, more or less covering the upper surface of the leaves, black-brown; teleutospore heads chestnut-brown, irregularly orbicular, an occasional head with one or two short papillae on

its surface, 50-75 by 30-35 μ thick; 4-6 spores in cross section; cysts hyaline, globose, many, beneath the entire head, 15-18 μ in diameter; pedicel compound, short, hyaline.

On *Cassia bauhinioides*: Mesilla Park, N. M., Oct. 1897, E. O. Wootton (type ex. Herb. E. Bartholomew); same station and collector, October 1895 (ex. Herb. A. & M. College, N. M.).

Ravenelia fragrans, n. sp.—*Fig. 14.*

Sori breaking forth between the cuticle and the epidermal cells, small, scattered or often densely confluent on the leaves and leaf stems. Primary uredosori usually densely confluent on leaves and stems and young branches, causing them to become swollen and collected into globose bundles or "witches' brooms," 0.5-2 ^{cm} in diameter; later uredosori more or less scattered over the leaves, often densely confluent over the entire surface of the young pods, tawny, sori small, usually less than 1 ^{mm} in diameter and on both sides of the leaves; uredospores fulvous, walls thick, primary spores globose, often angular, later ones oval to globose, densely spinulose, 13-17 by 17-23 μ ; germ pores many, scattered; paraphyses very abundant, clavate, 40-50 by 5-12 μ , heads fulvous, pedicel hyaline. Teleutosori small, less than 1 ^{mm}, black-brown, on both sides of the leaves and on the leaf stems; teleutospore heads chestnut-brown, papillate, orbicular, 70-85 by 30-35 μ thick; spores 5-6 in cross section, each with several (3-4) short hyaline papillae, 17-20 by 33-38 μ , tips intensely dark brown for 7 μ ; cysts ovate-oblong, hyaline, beneath entire head, pendent; pedicel hyaline compound, short, deciduous.

On *Mimosa fragrans*: Austin, Texas, June 7, 1901, no. 142.

This species is very closely related to *Ravenelia expansa*, but differs from it in the cysts being beneath the entire head, while in *R. expansa* they are only under the marginal spores; the paraphyses are narrower and more abundant, and the uredospores are darker and more elliptical than those of *R. expansa*. This rust was collected during June and July; very few teleutosori were present; by the close of July all the infected leaves had fallen from the host.

RAVENELIA SPINULOSA Diet. and Holw., BOT. GAZ. 31: 336. 1901.—*Fig. 15.*

Sori breaking forth between the cuticle and the epidermal

cells, on both sides of the leaves. Uredosori ochre color, often confluent in effused patches, 0.5–1 mm in diameter; uredospores oval to spheroid, densely echinulate, light brown, 17–20 by 20–30 μ , usual size 18 by 25 μ ; germ pores many, scattered; paraphyses rare, capitate-clavate, much attenuated toward base, hyaline, 10–15 by 30–50 μ . Teleutosori black-brown, small, scattered; teleutospore heads chestnut-brown, papillate, irregularly orbicular, 50–120 by 30–40 μ thick; 5–7 spores in cross section, each with a single hyaline (2–7 μ) papilla; cysts hyaline, globose, 13–15 μ in diameter, pendent, beneath the entire head; pedicel short, hyaline, deciduous, compound.

On *Cassia Lindheimeriana*: San Marcos, Texas, Nov. 19, 1901; Marble Falls, Texas, March 30, 1901; Austin, Texas, Aug. 24, 1901, no. 1026; Austin, Texas, Oct. 5, 1901, leg. *A. M. Ferguson*.

On *Cassia multiflora*: Oaxaca, Mexico, Oct. 18, 1899, no. 3675 (type) *Holway*.

RAVENELIA ARIZONICA Ell. and Ev., Bull. Torr. Bot. Club 22: 363–364. 1895; Saccardo Syll. Fung. 14: 367. 1899.—*Fig. 16.*

Sori subepidermal, on both sides of the leaves but mainly on the under side. Uredosori chestnut-brown, firm, scattered, 0.5–1 mm broad, oval to orbicular; uredospores obovate to oblong-ovate, spinulose, light brown, apex often darker, 17–20 by 28–36 μ ; germ pores 4, equatorial; paraphyses of two kinds, normal form capitate, heads dark brown, walls thick; pedicel usually hyaline, somewhat attenuated toward base; heads 20–23 μ in diameter, pedicels 30–60 by 7 μ ; the other form cystoid, walls thin, clavate-fusiform with apex nipple-shaped, slightly fulvous, rare. Teleutosori dark brown, orbicular, 80–100 μ in diameter, spinous; 6–8 spores in cross section, tips intensely brown for 6 μ , 10–15 by 25–33 μ , each crowned with a curved hyaline spine 4–6 μ long; cysts hyaline, spheroid in a dense cluster beneath the head, pendent, swelling and bursting in water; pedicel compound, hyaline, short, deciduous.

On *Prosopis juliflora*: Abilene, Texas, 1900, no. 1481, Ell. and Ev. Fung. Col. continued (issued as *R. decidua* (Pk) Holw.).

On *Prosopis velutina*: Tucson, Ariz., no. 37, *J. W. Toumey* (type); also Oct. 21, 1894, *J. W. Toumey*; Nov. 1900, no. 252 and no. 252a, West Am. Fung.

The no. 252a of West American Fungi is very interesting, as the uredospores are borne on large woody galls, which are densely covered with the confluent sori; the spores on these vary greatly in shape and size. The galls, Mr. Griffiths writes me, are perennial, bearing successive crops of uredospores year after year. The teleutospores are on the leaves of the same trees that have the uredospore-bearing galls, but no teleutospores were found on the galls. This gall-bearing stage is very similar to the aecidial stage of *Neoravenelia Holwayi*, only in this case the spores are not in chains, but are true uredospores and are intermixed with the characteristic paraphyses. The galls also are larger and woody, while those of *Neoravenelia Holwayi* are brittle, and shrink very much in drying, and are annual.

This species was originally reported as on *Prosopis juliflora*; but this, Dr. David Griffiths writes me, was an error, as the host is *Prosopis velutina* Wooton.

RAVENELIA APPENDICULATA Lagerh. and Diet., Hedwigia 33: 47, 65. 1894; Saccardo, Syll. Fung. 11: 210. 1895.—Fig. 8.

Sori subepidermal, mainly on the under side of the leaves, scattered. Uredosori cinnamon color, small; uredospores fulvous to hyaline, ovate, verrucose, 20–23 by 26–30 μ , germ pores four, equatorial; paraphyses clavate, stout; heads evenly brown, 17–24 by 29–30 μ ; pedicel hyaline, short, 26–33 by 7 μ . Teleutosori small, black; teleutospore heads irregularly orbicular, chestnut-brown, 65–90 μ in diameter, appendaged; 4–5 spores in cross section, 18–20 by 25–30 μ , each with a long (8–12 by 5 μ) fulvous appendage which is branched at the apex; cysts hyaline, peripheral, pendent; pedicel compound, hyaline, short, deciduous.

On *Phyllanthus galeottinus*: Cuernavaca, Mexico, Sept. 15, 1899; also Guadalajara, Mexico, Oct. 12, 1896, *Holway*.

On *Phyllanthus* sp.: Ecuador, prov. Chimborazo, Puente de Chimbo, Aug., 1891, *G. v. Lagerheim*.

RAVENELIA MEXICANA Transchel, Dietel in Hedwigia 33: 370. 1894.—Fig. 25.

Sori breaking forth between the cuticle and the epidermal cells, scattered, on both sides of the leaves, very small, fulvous, surrounded by the ruptured cuticle. Uredospores intermixed with teleutospores (rare in specimens examined), ovate to spheroid, fulvous, echinulate; germ pores 4 (?), equatorial, walls thin, 18–20 by 23–25 μ ; paraphyses in separate sori,

clavate-capitate; heads light brown; pedicel hyaline, 18–20 by 40–55 μ . Teleutospore heads light brown, spinous, irregularly orbicular, 60–80 by 35 μ thick; spores 4–5 in cross section, each crowned with 2–4 blunt, curved hyaline spines, which range from mere warts to spines 8 μ long by 4 μ thick at base; cysts when dry, flat, and closely appressed to the under side of the heads, but in water swelling into an oblong shape and finally bursting, peripheral; pedicel weak, short, deciduous.

On *Calliandra grandiflora* Benth.: Mexico, State of Jalisco, mountains near Lake Chapale, Sept. 12, 1889, leg. *Pringle*.

The spines in this species are very variable in size and shape. Very few uredospores were present in the specimen examined, which was a part of the type collection kindly sent me by Dr. Dietel. For this reason, the number and position of the germ pores could not be determined with certainty.

***Ravenelia leucaenae*, n. sp.—*Fig. 23*.**

Sori breaking forth between the cuticle and the epidermal cells, mainly on the upper side of the leaves, scattered very sparingly on the leaf stems. Uredosori cinnamon-brown, very small, from punctate to 0.4–0.6^{mm}, elliptical, surrounded by the ruptured cuticle; uredospores pale brown, base often semi-hyaline, with a darker but unthickened apex, oblong-linear to oblong-oval and sometimes oblong-ovate, usual shape oblong-linear, sparsely spinulose, 15–18 by 35–50 μ ; germ pores 4, in the equator or between it and the base of the spore; paraphyses common, semi-hyaline, fulvous at apex, subclavate to subcapitate, walls very thin, often collapsed, 18 by 40–50 μ . Teleutosori chestnut-brown, small, 0.4–0.6^{mm} in diameter, surrounded by the ruptured cuticle; teleutospore heads chestnut-brown, orbicular, 65–90 by 35–40 μ thick, papillate; 5–6 spores in cross-section, each spore crowned with several hyaline papillae 4–7 by 2–3 μ .; cysts oblong-ovate, flattened at base, peripheral, hyaline, swelling and finally bursting in water; pedicel short, hyaline, deciduous, apparently of separate hyphae.

On *Leucaena diversifolia*: Etna, Oaxaca, Mexico, Oct. 25, 1899, no. 3826, *Holway* (type).

On *Leucaena* sp.: Iguala, Mexico, Oct. 3, 1900, *Holway*.

This species is related to *R. goyazensis*, but differs from it in its shorter and hyaline papillae, in the shape of its cysts, and in the very small size of

its sori. It differs from *R. Pazschkeana* Diet. in the unthickened apices of its uredospores and in the longer papillae, and in being subcuticular while *R. Pazschkeana* is sub-epidermal.

PLEORAVENELIA, n. gen.

Spermogonia formed between the cuticle and the epidermal cells, hemispherical. Aecidia with a well developed pseudo-peridium. Uredospores borne singly on short stalks; germ pores few or many; paraphyses usually present in the uredosori. Teleutospores united into cushion-like heads formed of several or many cells; inner teleutospores two-celled by transverse or more or less oblique septa; outer spores one-celled; under side of teleutospore heads with several or many hyaline cells or cysts; pedicel of the head of several hyphae, which are either separate or united into a compound stipe.¹

KEY TO SPECIES.

- | | | |
|---|-----------|-------------------------|
| 1. Teleutospore heads smooth | - - - - - | 2 |
| Teleutospore heads rough, warty, etc. | - - - - - | 3 |
| 2. Uredospore germ pores many (12-15), scattered; paraphyses many, clavate | - - - - - | <i>P. laevis</i> |
| Uredospore germ pores 6-13, equatorial; paraphyses none | - - - - - | 4 |
| 3. Uredospore germ pores many, scattered; paraphyses many; teleutospore heads papillate | - - - - - | <i>P. indigoferae</i> |
| Uredospore germ pores many, scattered; teleutospore heads warty and appendaged at base | - - - - - | <i>P. brongniartiae</i> |
| Uredospore germ pores 4-6, equatorial; teleutospore heads minutely verrucose | - - - - - | <i>P. talpa</i> |
| 4. Germ pores 6. Uredospores fulvous, 25 by 34 μ | - - - - - | <i>P. epiphylla</i> |
| Germ pores 8-12; uredospores brown, 20 by 25 μ | - - - - - | <i>P. similis</i> |

Pleoravenelia laevis (Diet. and Holw.)—*Fig. 17.*

Ravenelia laevis Diet. and Holw., BOT. GAZ. 27:35. 1897; Saccardo, Syll. Fung. 14:366. 1899.

Sori subepidermal, on yellow spots on both sides of the leaves. Uredosori cinnamon color, few, small, surrounded by the ruptured epidermis; uredospores brown, oval to globose, spinulose, 21-26 by 22 μ ; germ pores many (15 or more), scat-

¹The other Ravenelias with the inner spores two-celled, which are not included in this paper, will also come under the new genus *Pleoravenelia*, and should be written ***Pleoravenelia Hieronymi*** (Speg), ***P. MacOwaniana*** (Pazschke), ***P. glabra*** (Kalchbr. and Cke.), and ***P. tephrosiae*** (Kalchbr.).

tered; paraphyses large, clavate, many, uniformly brown; heads 26–35 by 40 μ ; stipe 40–65 by 10–12 μ , hyaline. Teleutosori black-brown, from punctate to 1^{mm} in diameter, abundant; teleutospore heads irregularly orbicular, dark brown, opaque, smooth, 85–120 μ in diameter; 5–6 spores in cross section; cysts cushion-shaped, connate with the pedicel, peripheral; pedicel compound, short, hyaline.

On *Indigofera densifolia*: Oaxaca, Mexico, Oct. 18, 1899, no. 3661, Holway.

On *Indigofera* sp.: Esclava, near City of Mexico, Oct. 3, 1896, Holway.

Differs from *P. epiphylla* and *P. similis* in having paraphyses, and in the numerous germ pores (15 or more).

Pleoravenelia similis, n. sp.—*Fig. 21.*

Sori subepidermal, on effused yellow spots, from punctate to 0.5^{mm} in diameter, on both sides of the leaves but especially abundant on the upper surface and more or less confluent over large areas. Uredosori few, ochraceous, small; uredospores brown, walls thick and dark brown, spinulose, oval to subglobose and often ovate, 20–28 by 17–23 μ ; germ pores 8–12, irregularly scattered in or near the equatorial zone; paraphyses none. Teleutosori black-brown; teleutospore heads smooth, irregularly orbicular to oval, chestnut-brown, 68–135 μ , usual size 100 μ ; 6–8 spores in cross section; cysts hyaline, peripheral and decurrent into the pedicel; pedicel hyaline, compound, short.

On *Brongniartia*: Guadalajara, Mexico, Sept. 14, 1899, no. 3145, Holway (type); also Oct. 1896, Holway.

The uredospores of this species blacken very much under continued boiling in lactic acid and glycerine solution, and shrink somewhat, while the uredospores of *P. epiphylla* do not blacken or shrink. It also differs from *P. epiphylla* in the number of germ pores, and in the brown uredospores.

Pleoravenelia epiphylla (Schw.)—*Fig. 18*

Sphaeria epiphylla Schw., Syn. Fung. Carol no. 130 p. 40. 1822; Saccardo, Syll. Fung. 2: 399. 1883; Farlow, Host Index 30. 1888; Ellis and Everhart, N. A. Pyren. 745. 1892.

Ravenelia glanduliformis Berk. and Curt., Cooke in Jour. Roy. Micr. Soc. 3:385. 1880; Grevillea 3:56. 1874; Parker, Proc. Amer. Acad. 21:205–

217. 1886; Atkinson, Some fungi from Alabama, Bull. Cornell Univ. Science 3:20. 1897.

Ravenelia epiphylla Dietel, Hedwigia 3:27-29, 59. 1894.

Sori subepidermal, on both sides of the leaves and on the leaf stems and branches, scattered, crowded or confluent. Uredosori small, ochraceous, surrounded by the ruptured epidermis, scattered, usually confined to the leaves; uredospores fulvous to semi-hyaline, walls thin, broadly oval to broadly ovate, verrucose, 30-40 by 23-26 μ , usual size 34 by 25 μ ; germ pores 6, in the equator; paraphyses none. Teleutosori on both stems and leaves, scattered or confluent, black-brown; teleutospore heads chestnut-brown, very variable as to size and shape, smooth, 80-115 by 33-45 μ thick; 4-7 spores in cross section; cysts hyaline, decurrent into the pedicel; pedicel short, hyaline.

On *Tephrosia virginiana*: South Carolina, 1876, *Ravenel*, no. 1251, Thümen Myc. Univ. Fungi Car.; Rav. Fung. Car. no. 72; White Sulphur Springs, West Va., no. 705, *M. B. Waite*; Oregon, Ill., Sept. 3, 1886, no. 84, *M. B. Waite*; Munith, Mich., 1893, *G. A. Hicks*, no. 1787, Plants of Mich.

On *Tephrosia* sp.: South Carolina, *Aiken*, no. 55, Rav. Fung. Am. Exsic.

On *Tephrosia hispidula*: Auburn, Alabama, Sept. 9, 1893, *Duggar*; Auburn, Ala., Sept.-Oct. 1891, *Duggar* and *Atkinson*; Oct. 11, 1891, no. 2208, *Atkinson*; Center, N. Y., *Peck*, no. 363, Ell. N. A. Fung.

On *Tephrosia spicata*: Lake City, Florida, Oct. 16, 1899, no. 17, Fungi of Fla., *H. H. Hume*; Auburn, Alabama, no. 2146, *Atkinson*.

In all specimens of this species examined the uredospores were typical of the species and distinctly different from the uredospores of *P. similis* on *Brongniartia*.

***Pleoravenelia indigoferae* (Transz.)**.—*Fig. 19.*

Ravenelia indigoferae Transz., Dietel in Hedwigia 33:369, 1894; Saccardo, Syll. Fung. 11:211. 1895.

Sori subepidermal, on both sides of the leaves and on the leaf stems and branches. Uredosori sparse in material examined, pale yellow, small; uredospores oval to globose, 20-23 by 23-27 μ , epispore with sparse short prickles, light yellow; germ pores many, scattered; paraphyses many, clavate to subcapitate, brownish, walls of heads dark brown, contents faintly brown, 20-25 μ ; stipe hyaline, 50-80 by 7 μ . Teleutosori black, small, scattered on the leaves; on the stems and branches

confluent and causing large swollen places of several centimeters in extent; teleutospore heads irregularly orbicular, chestnut-brown, 80–125 μ broad, beset with pale brown papillae (3 by 4–6 μ); 4–6 spores in cross section, each spore crowned with several (4–8) papillae.

On *Indigofera cuernavacana* Rose: Cuernavaca, Mexico, Sept. 28, 1898, no. 3120, *Holway*.

On *Indigofera Palmeri* Wats.: Oaxaca, Mexico, Oct. 19, 1899, no. 3682, *Holway*.

Pleoravenelia brongniartiae (Diet. and Holw.)—*Fig. 20.*

Ravenelia brongniartiae Diet. and Holw., BOT. GAZ. 35: 1897; Saccardo, Syll. Fung. 14: 368. 1899,

Sori breaking forth from beneath the epidermis. Uredosori single or clustered, on both sides of the leaves, cinnamon-brown, spots large, yellow, about 5^{mm} in diameter; uredospores ovate to globose, 23–30 by 18–25 μ , spinulose; germ pores many, scattered; paraphyses none. Teleutosori not on spots, black; teleutospore heads orbicular, 85–115 μ in diameter, chestnut-brown, entire surface densely covered with large warts, while each marginal spore has one large dark brown blunt process; 5–6 spores in cross section, spores 16–21 μ long; cysts united into a coniform body which is decurrent into the pedicel; pedicel compound, short, hyaline.

On *Brongniartia* sp.: Cuernavaca, Mexico, Sept. 29, 1899, no. 3591, *Holway*; Sept. 28, 1898, no. 3022 and no. 3170, Sept. 23, 1896.

On *Brongniartia sericea*: Oct. 18, 1899, no. 3663, *Holway*.

On *Brongniartia intermedia*: Tizapan, near City of Mexico, Sept. 27, 1899, no. 3504 $\frac{1}{2}$, *Holway*.

All from Herb. E. W. D. *Holway*.

Pleoravenelia talpa, n. sp.—*Fig 22.*

Sori subepidermal, thickly distributed over both sides of the leaves. Uredosori few, ochraceous, surrounded by the ruptured epidermis, small; uredospores brown, walls thick, verrucose, ovate to subglobose, usually inequilateral, 25–32 by 18–22 μ , usual size 30 by 20 μ ; germ pores equatorial, 4–6, not easily visible even after boiling in lactic acid; paraphyses none. Telutosori small, black-brown, many, surrounded by the rup-

tured epidermis; teleutospore heads dark brown, irregularly orbicular to oval, minutely but distinctly verrucose, 65-115 by 35-40 μ thick, usual size 85 μ ; 4-8 spores in cross section, each spore crowned with several small scattered semi-hyaline warts, which are not arranged along the margins of the spores; cysts hyaline, peripheral, decurrent into the pedicel, swelling and bursting in water; pedicel compound, short, hyaline.

On *Tephrosia talpa* Wats.: Oaxaca, Mexico, Oct. 19, 1899, no. 3679, Holway.

This differs from *R. epiphylla* in its warty head, smaller and browner uredospores; and from *R. tephrosiae* in the very small warts of its teleutospores and in its larger uredospores, as a careful comparison with type specimens showed.

NEORAVENELIA, n. gen.

Spermogonia breaking forth between the cuticle and the epidermal cells, hemispherical. Aecidia without a pseudoperidium, borne caeoma-wise. Uredospores borne singly on short stalks; germ pores few or many; paraphyses usually present in the uredosori. Teleutospores united into cushion-like heads, formed of several or many spores; all the spores of the entire head one-celled; under surface of teleutospore heads with several or many hyaline cells or cysts; pedicel of the head of several hyphae, which are either separate or united into a compound stipe.

Neoravenelia Holwayi (Diet.) .—*Fig. 24.*

Ravenelia Holwayi Diet., Hedwigia 33:52-53, 61. 1894; Saccardo, Syll. Fung. 11:216. 1895.

Aecidial stage forming galls and cap-shaped excrescences on the leaves and leaf stems; galls oblong to globose, more or less curled and distorted, very variable in size, 1-4^{cm} long by 2-6^{mm} thick; "caps" on the leaflets 1-2^{mm} tall by 3-5^{mm} broad, with the concavity on the lower side of the leaflet; spermogonia on both sides of the "cap," subcuticular, preceding and with the aecidiospores, dark brown, 46-60 μ in diameter.

I. Aecidiosori deep seated, mummy-brown when fresh, ochraceous when desiccated, oblong to oval, 1-3^{mm} long by 1^{mm} broad, finally becoming more or less confluent over the entire surface of the galls, opening by a median longitudinal slit; sori

usually concentrically disposed on the convex and upper surface of the "caps;" pseudoperidium none; aecidiospores in chains, caeoma-wise, spores linear-oblong to subovate, very irregular in shape and size and often angular or prolonged into a point at one or both ends; walls thick, densely granular, light brown, 13-20 by 30-40 μ ; germ pores 4, equatorial, faint.

Uredo- and teleutosori subepidermal, on both sides of the leaves and sparingly on the leaf stems.

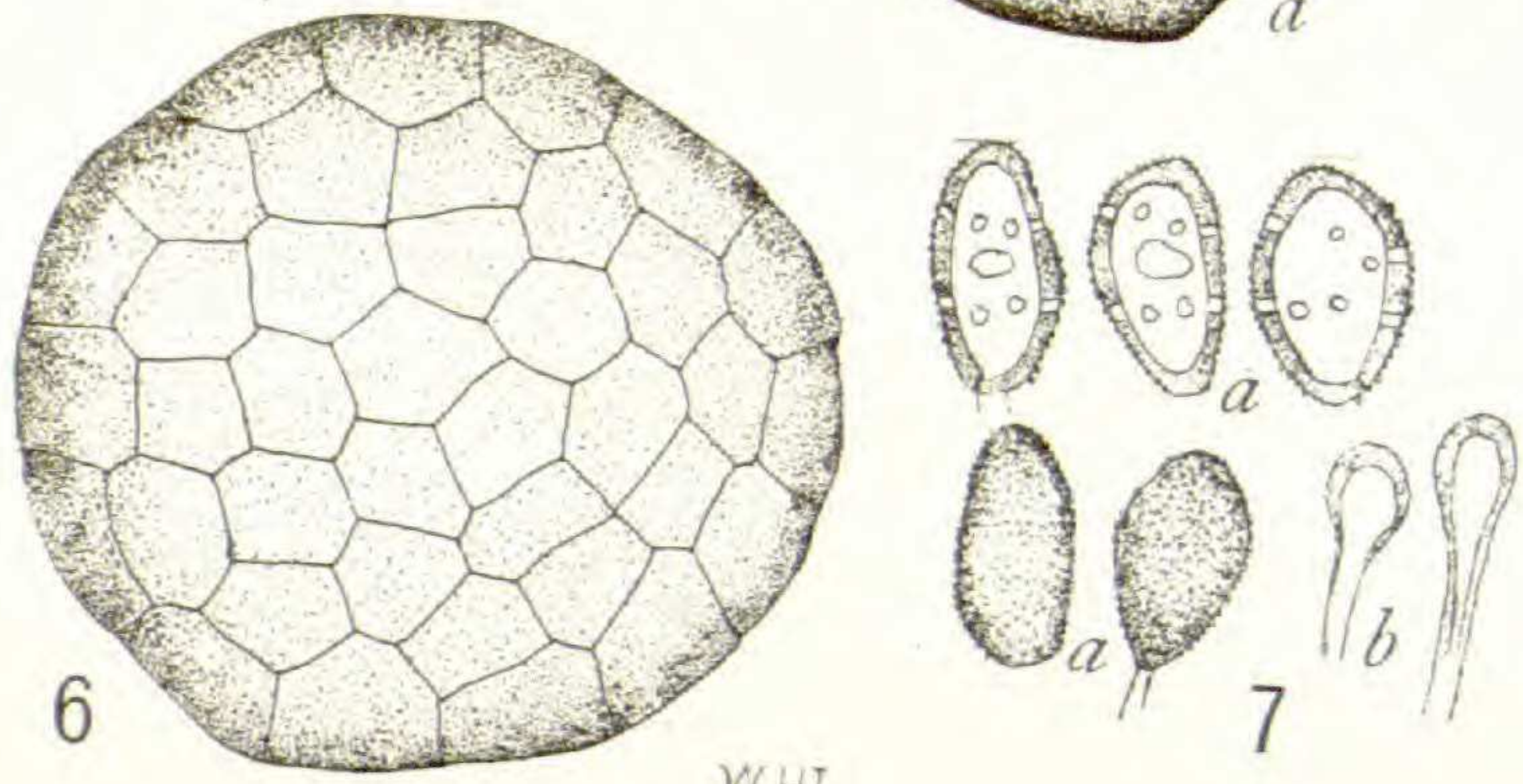
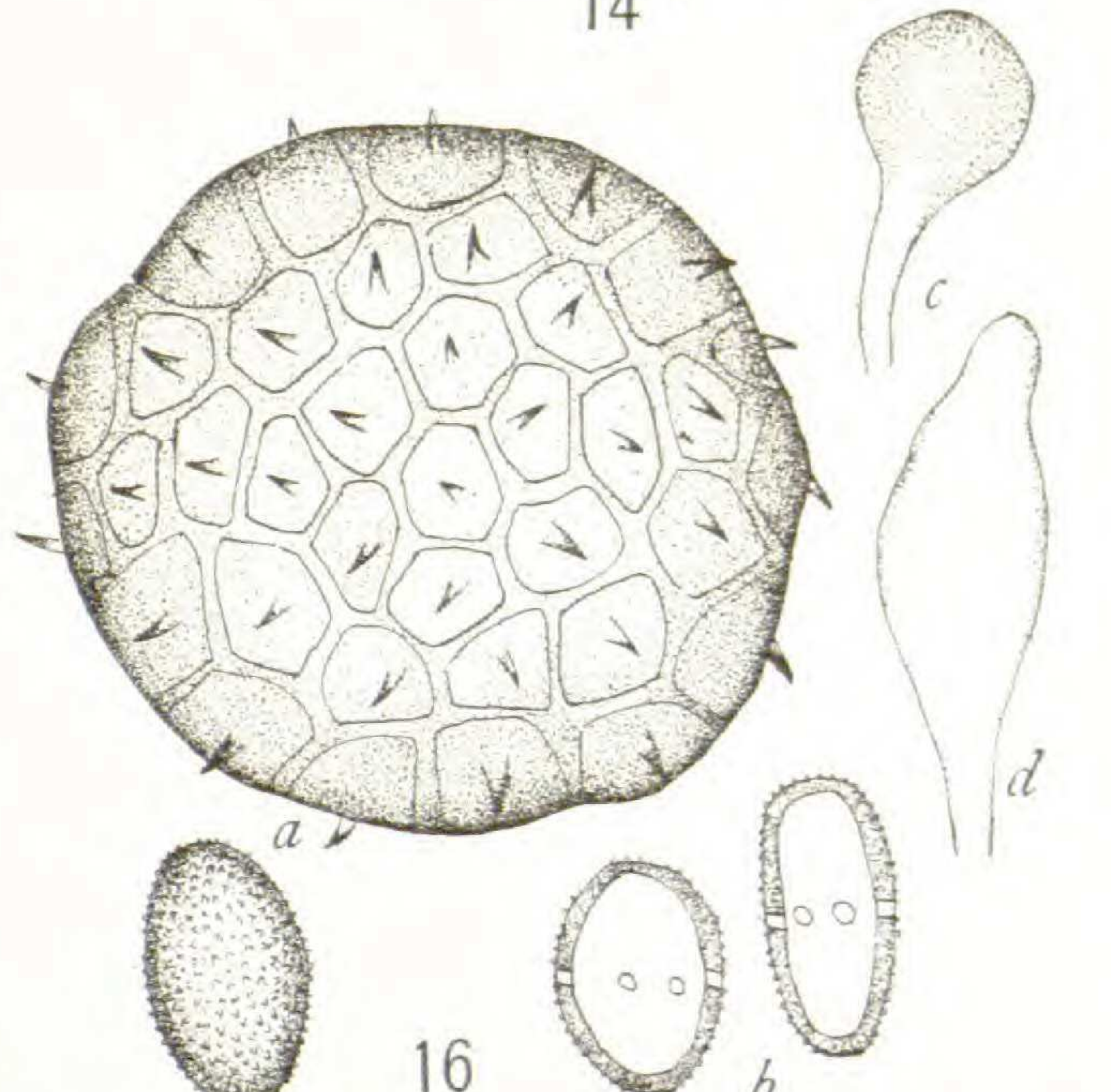
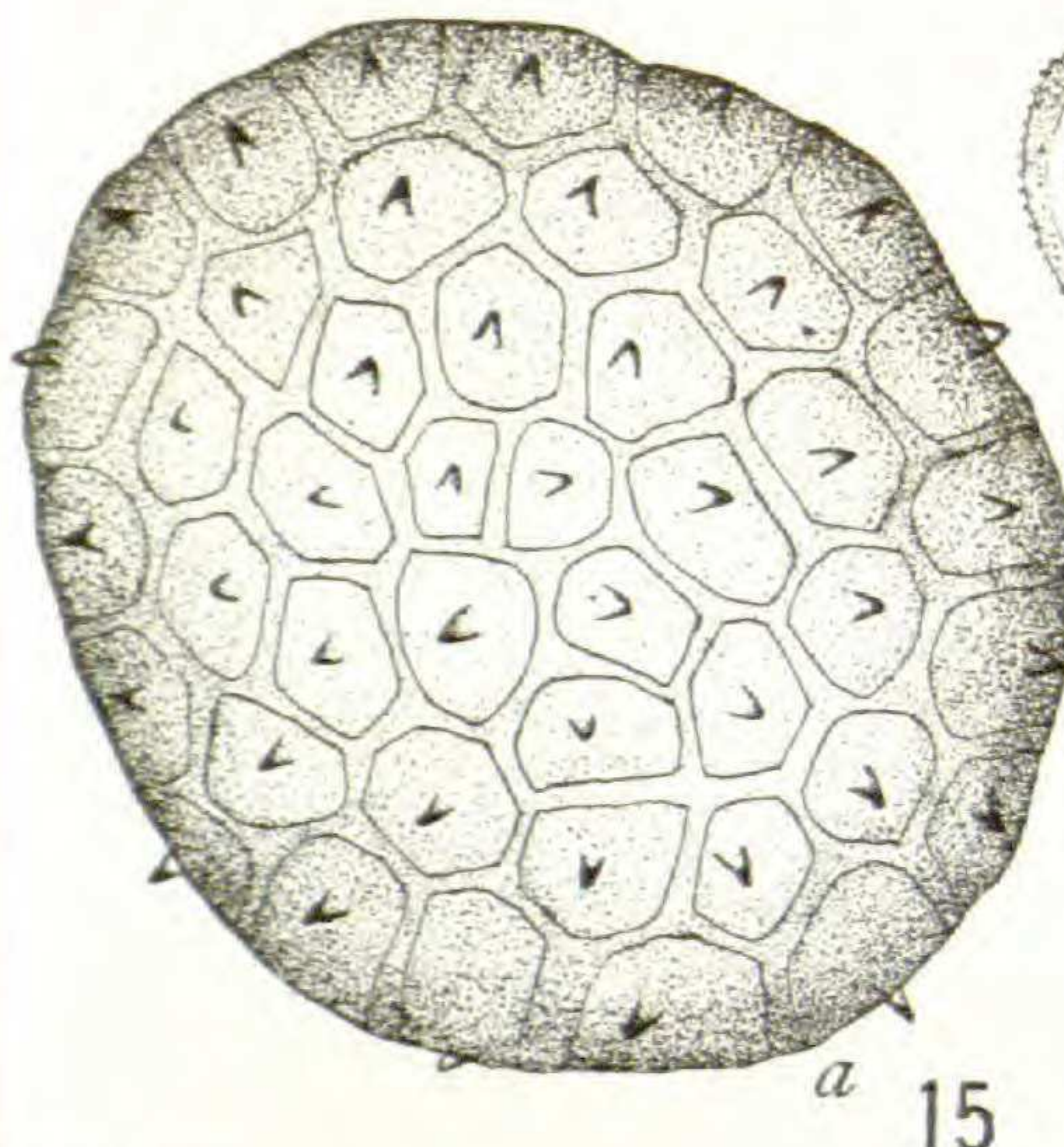
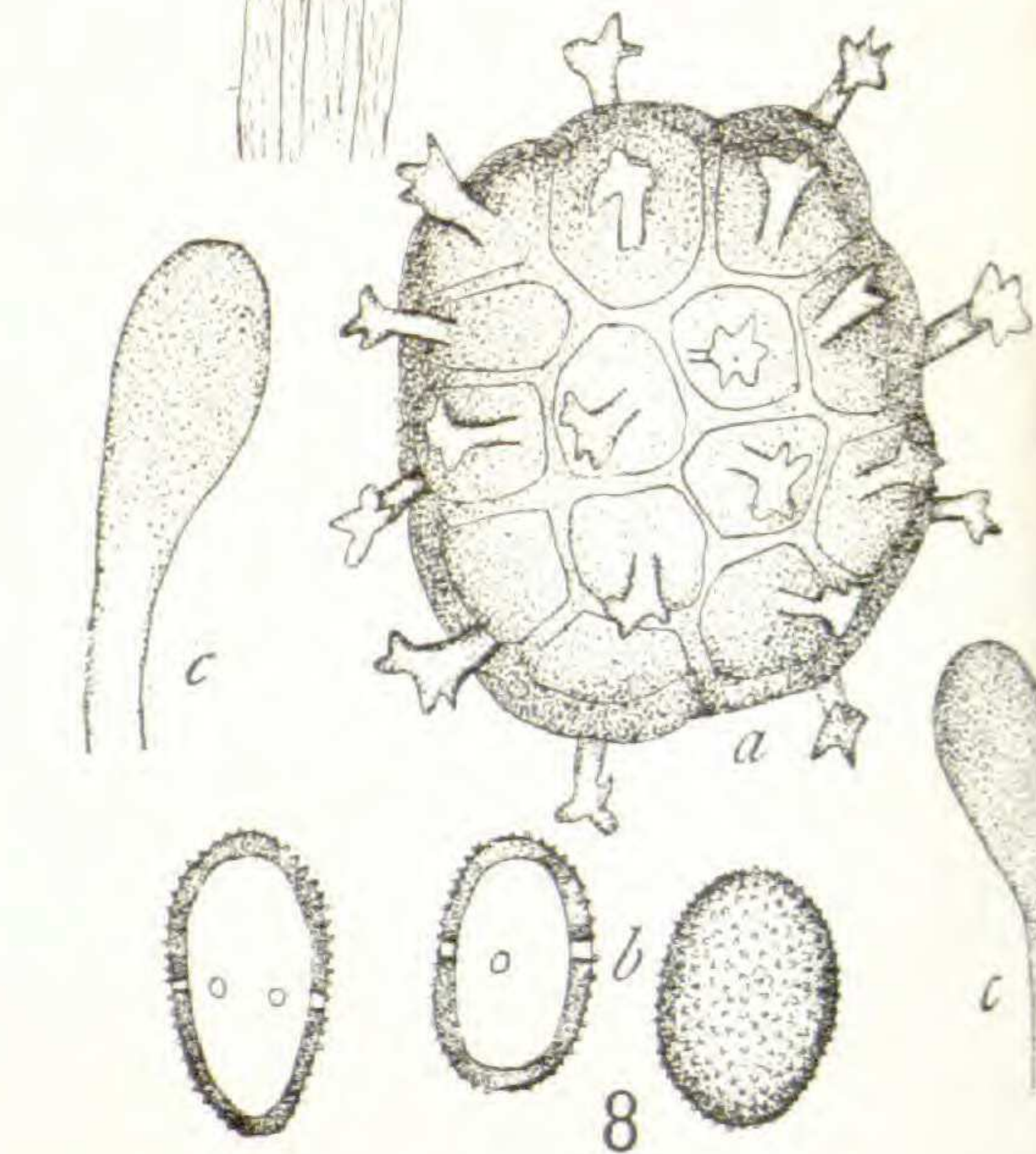
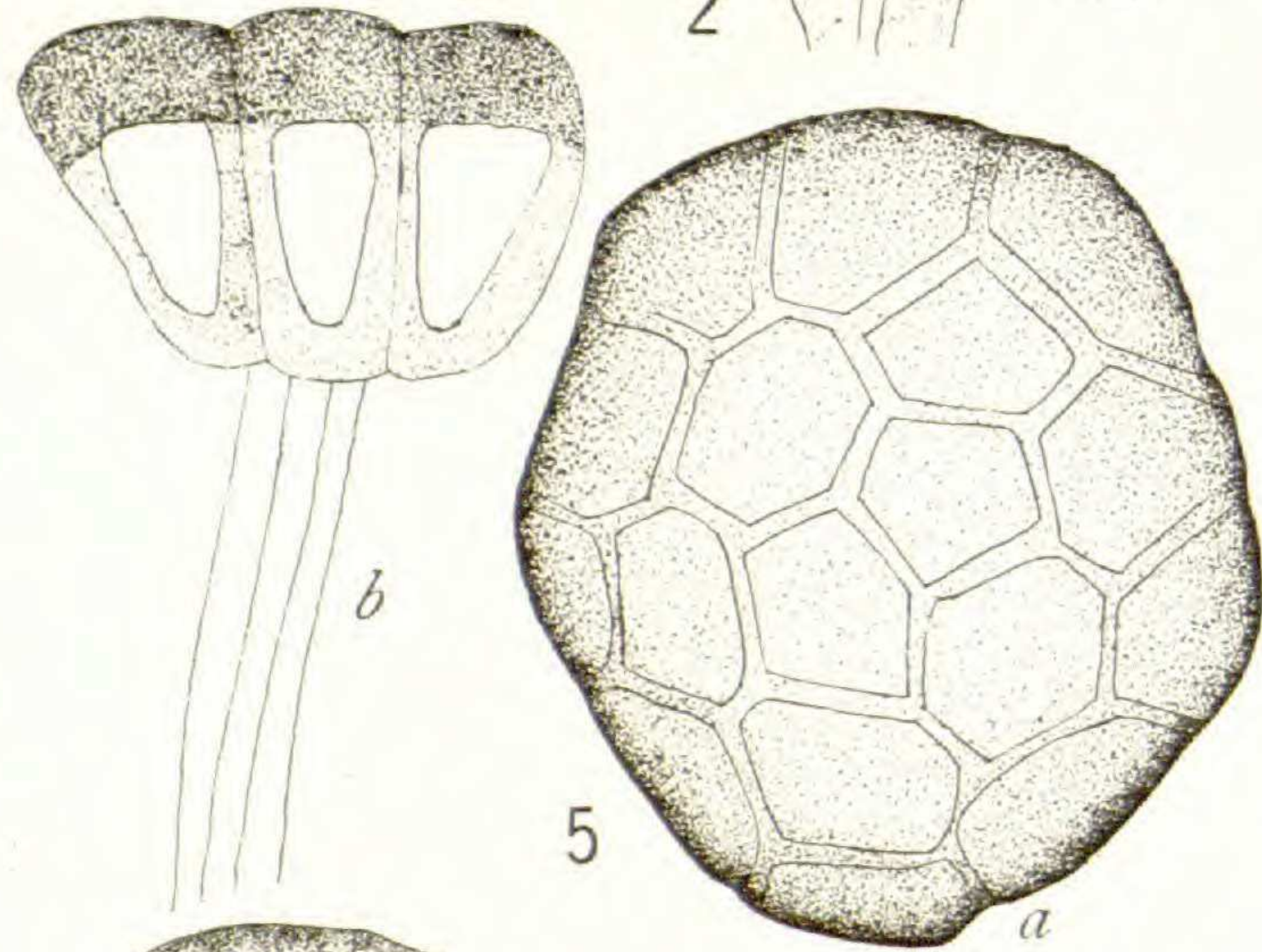
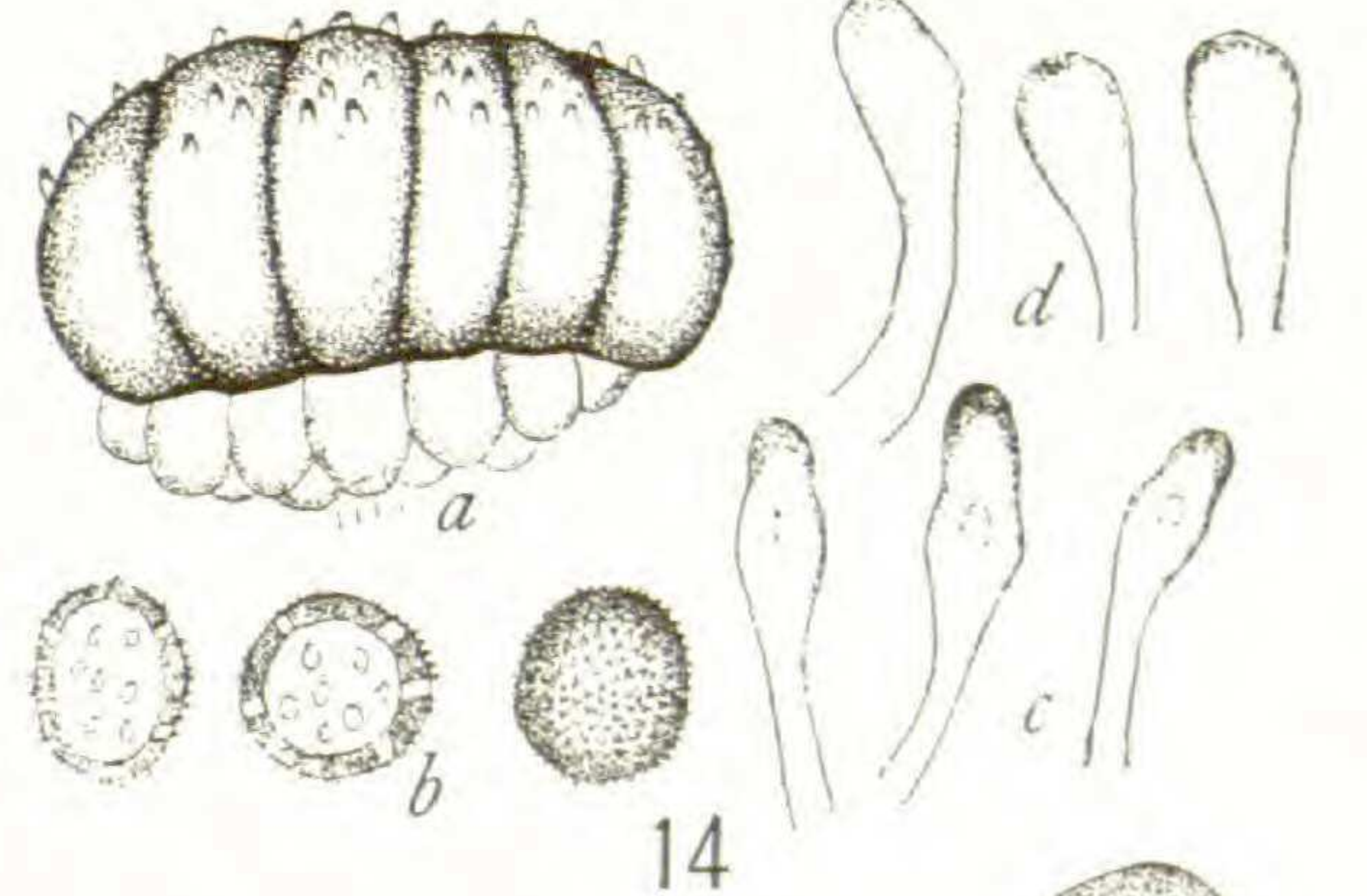
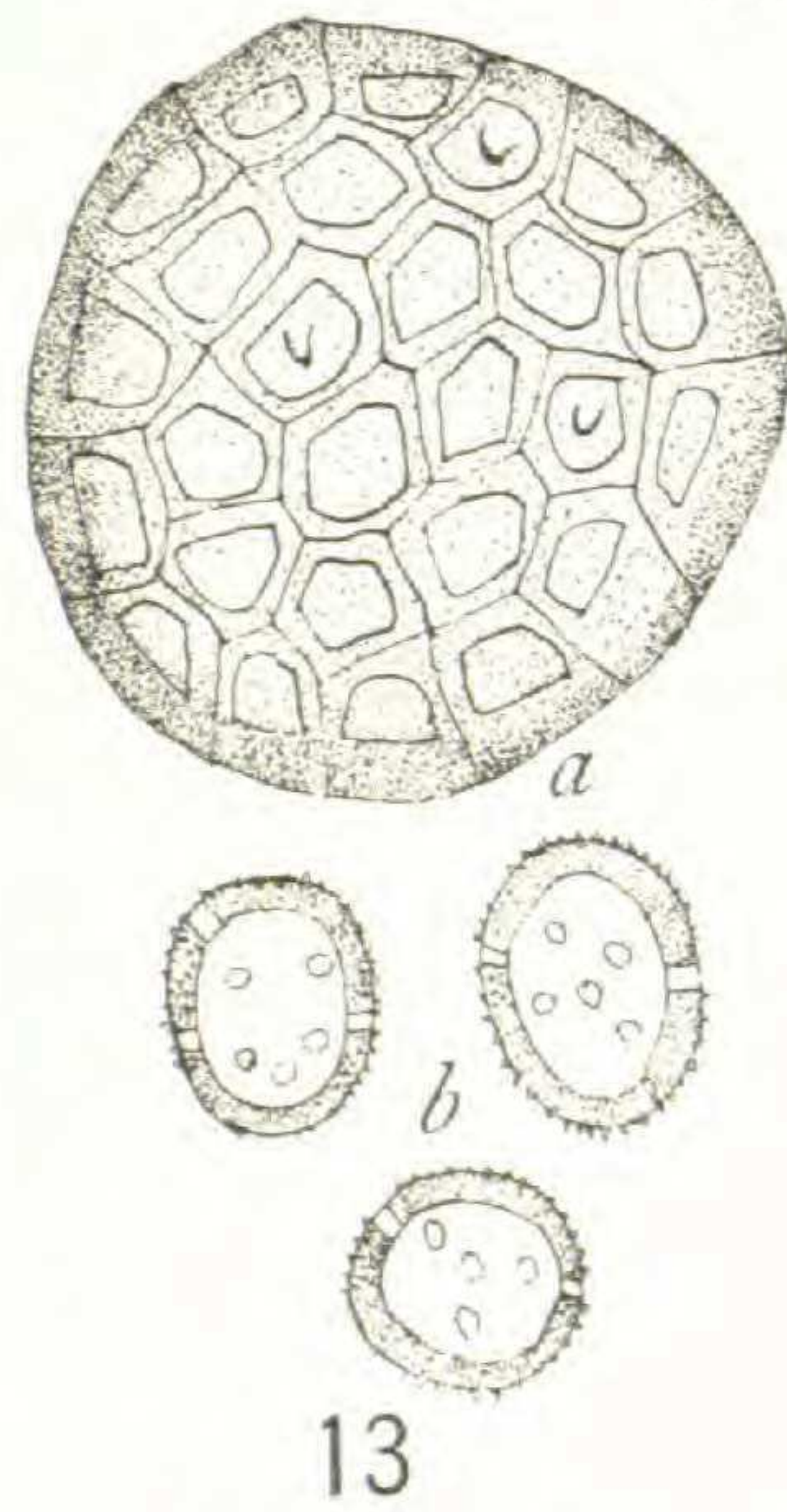
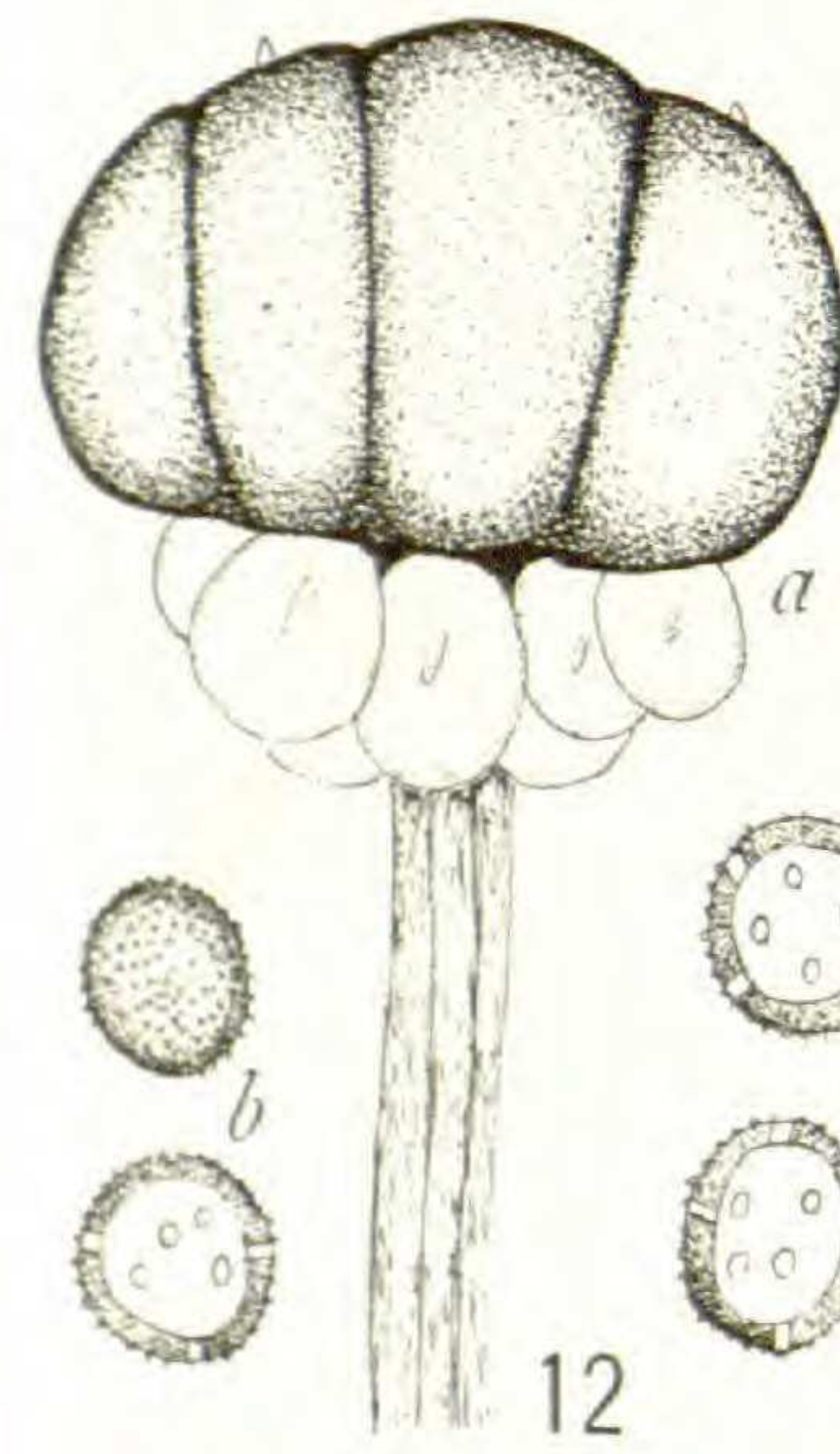
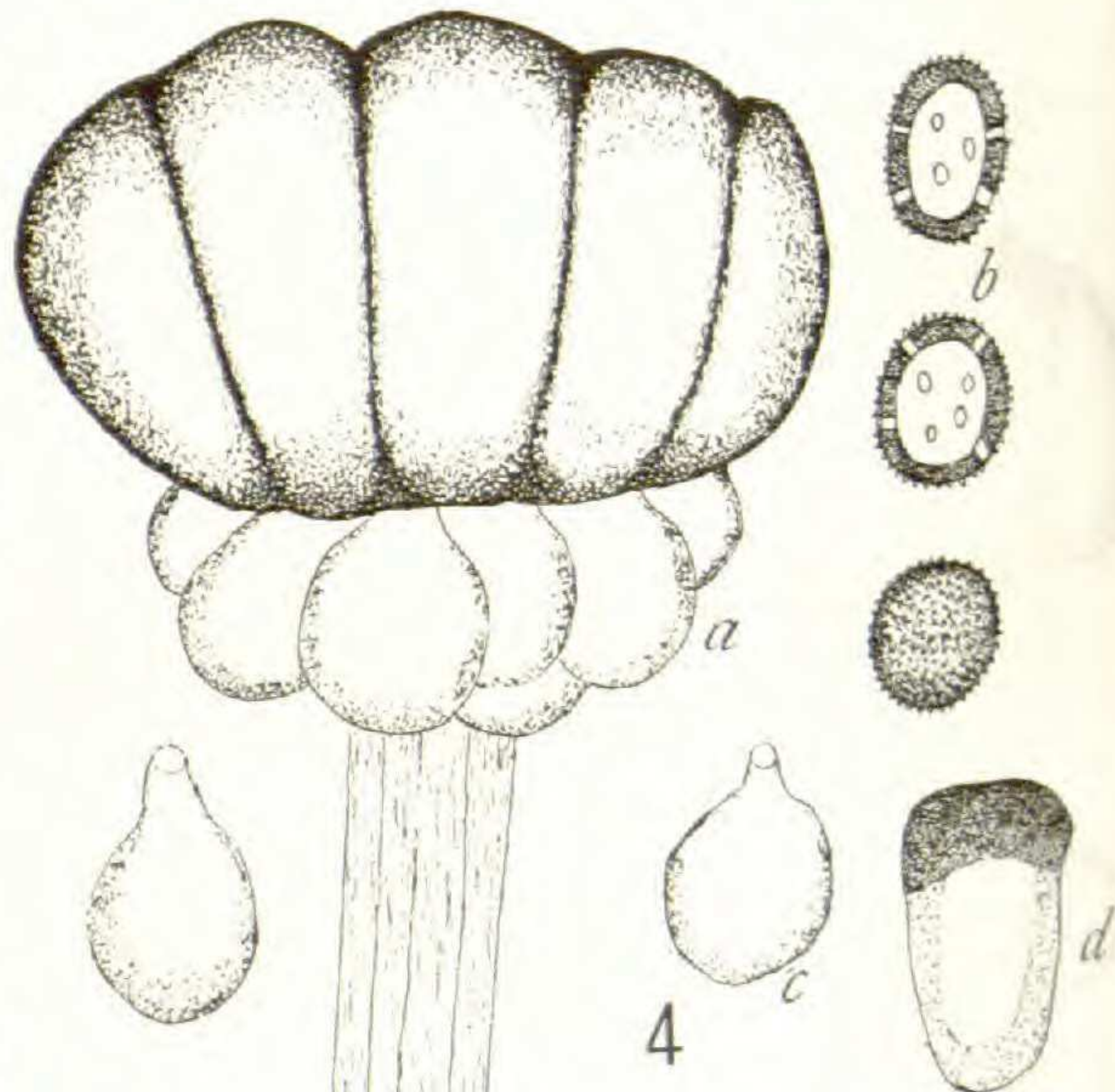
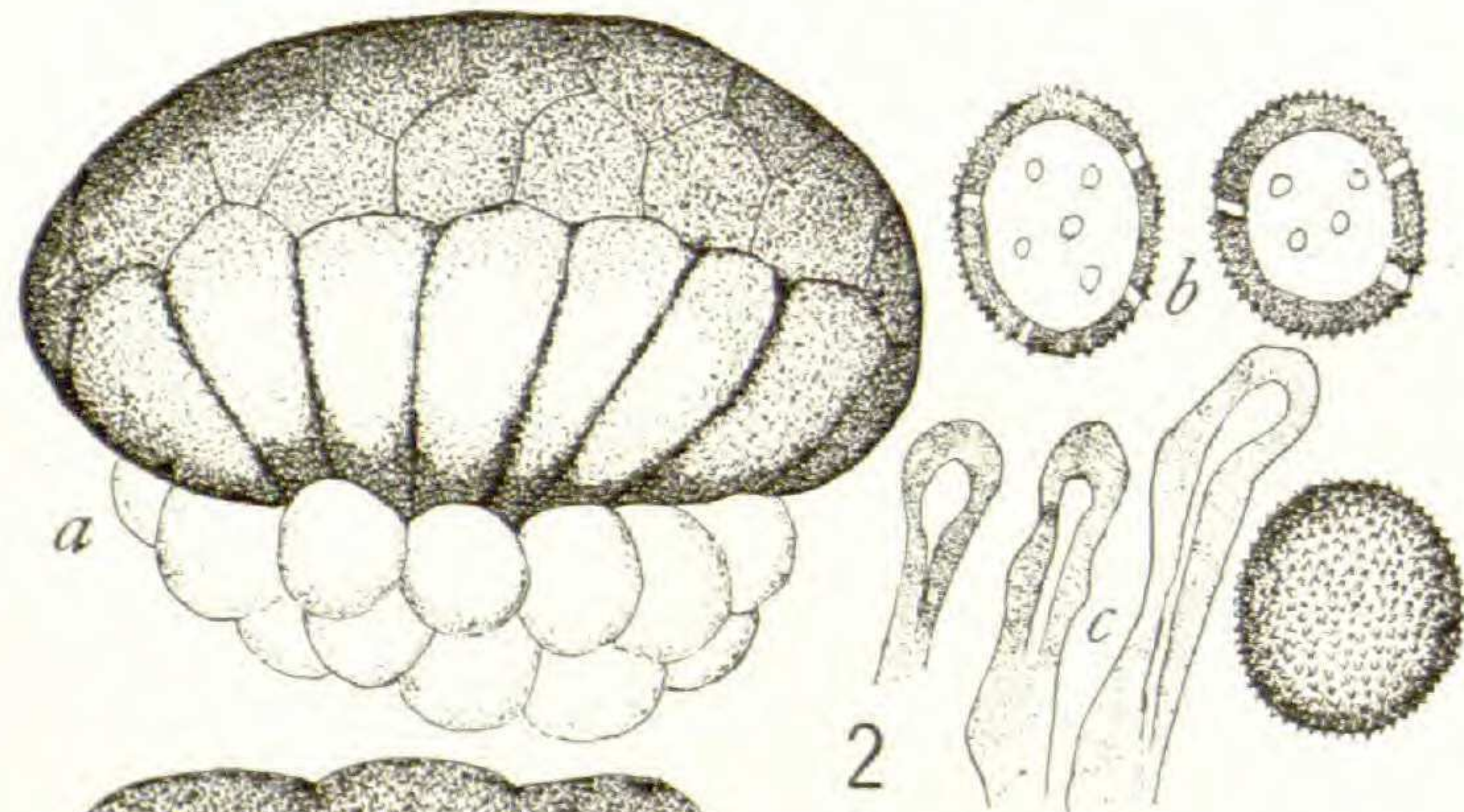
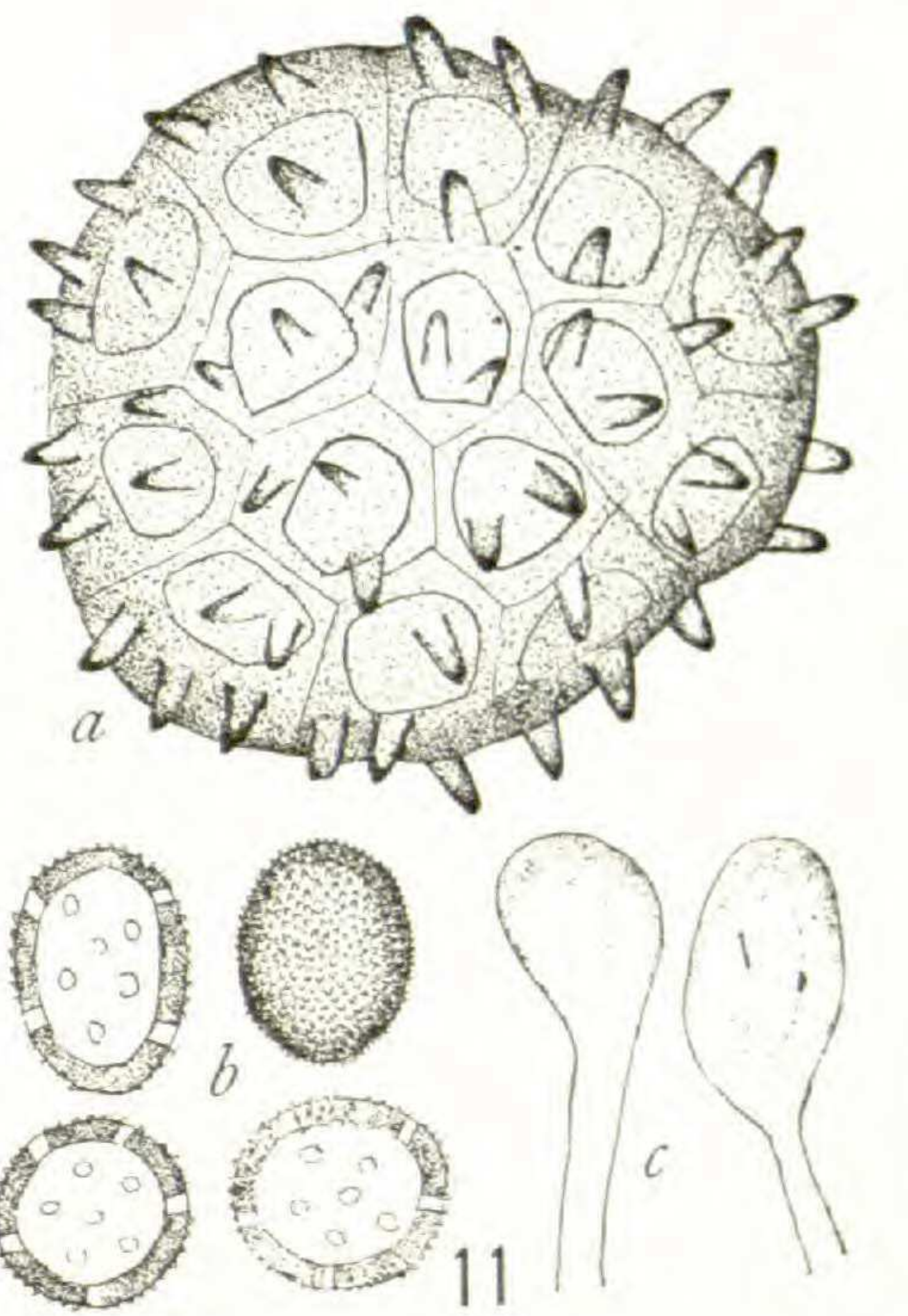
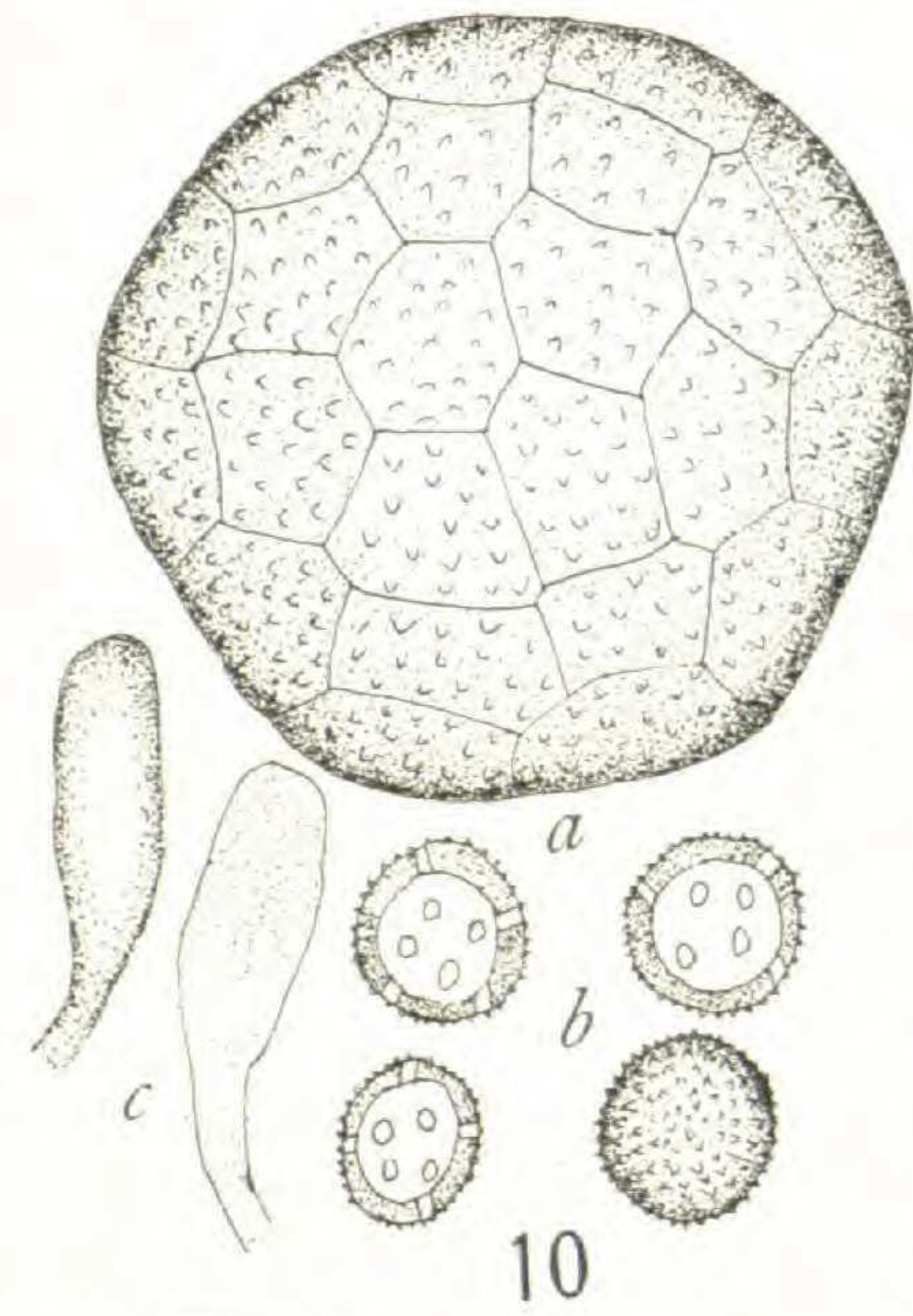
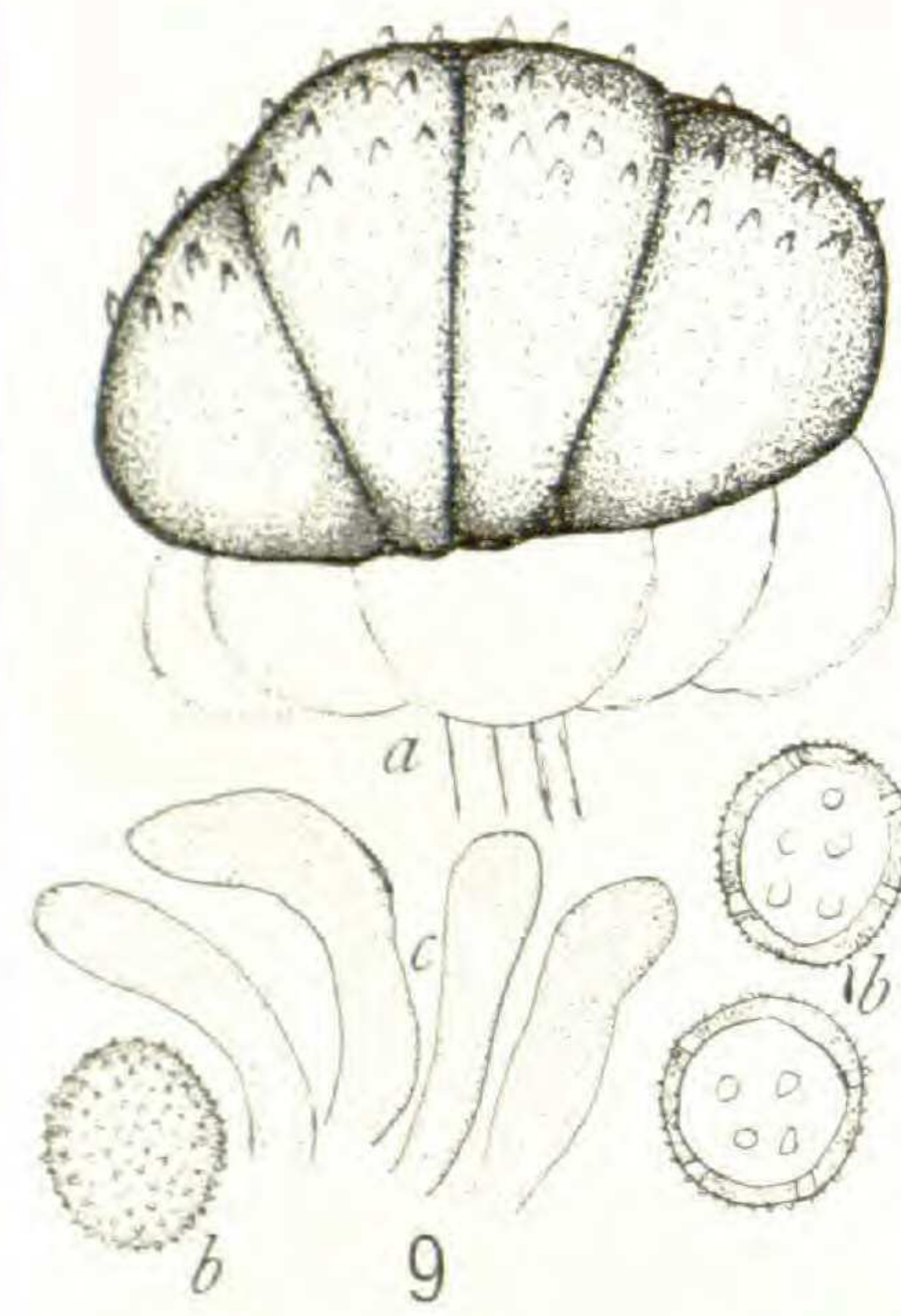
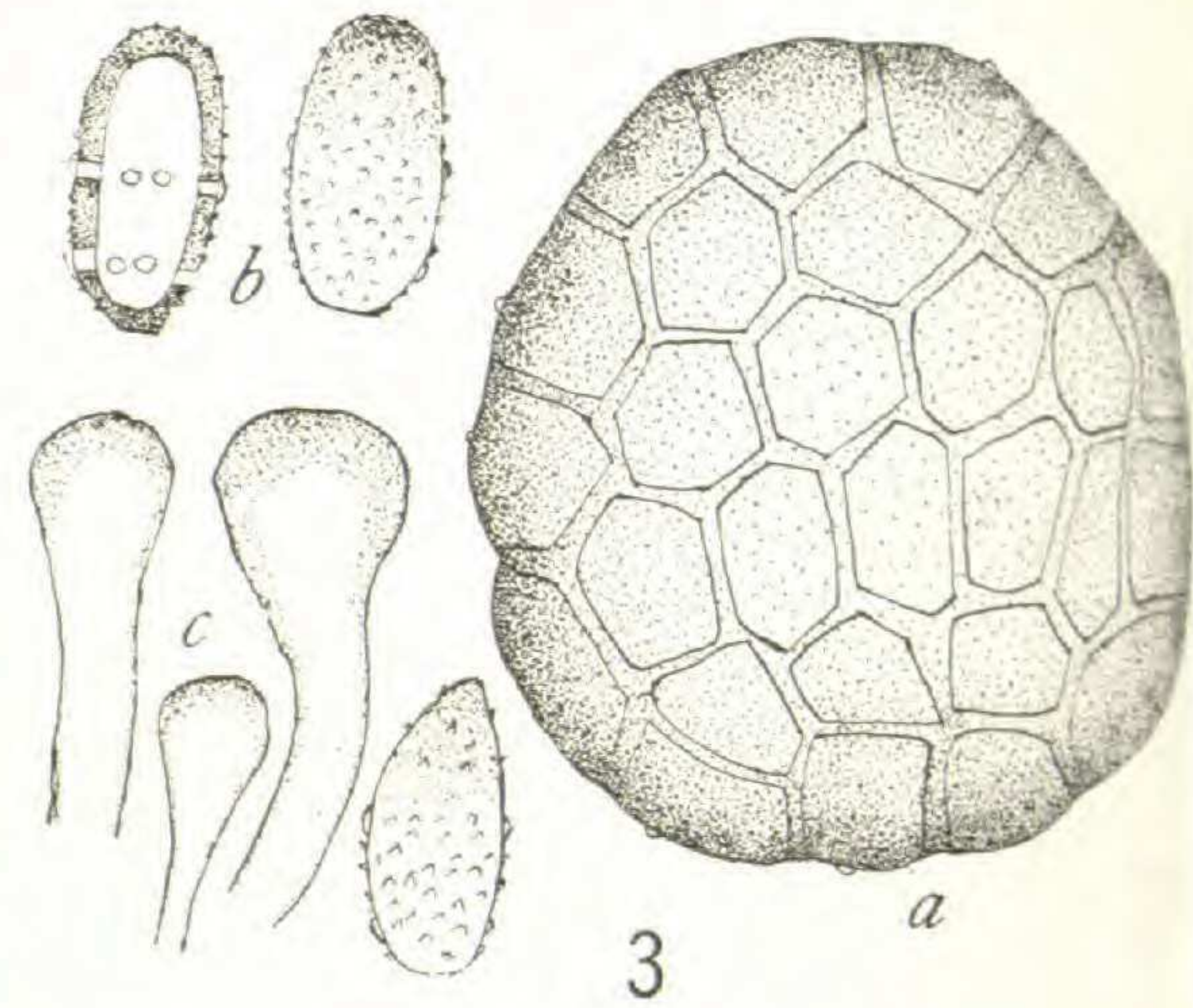
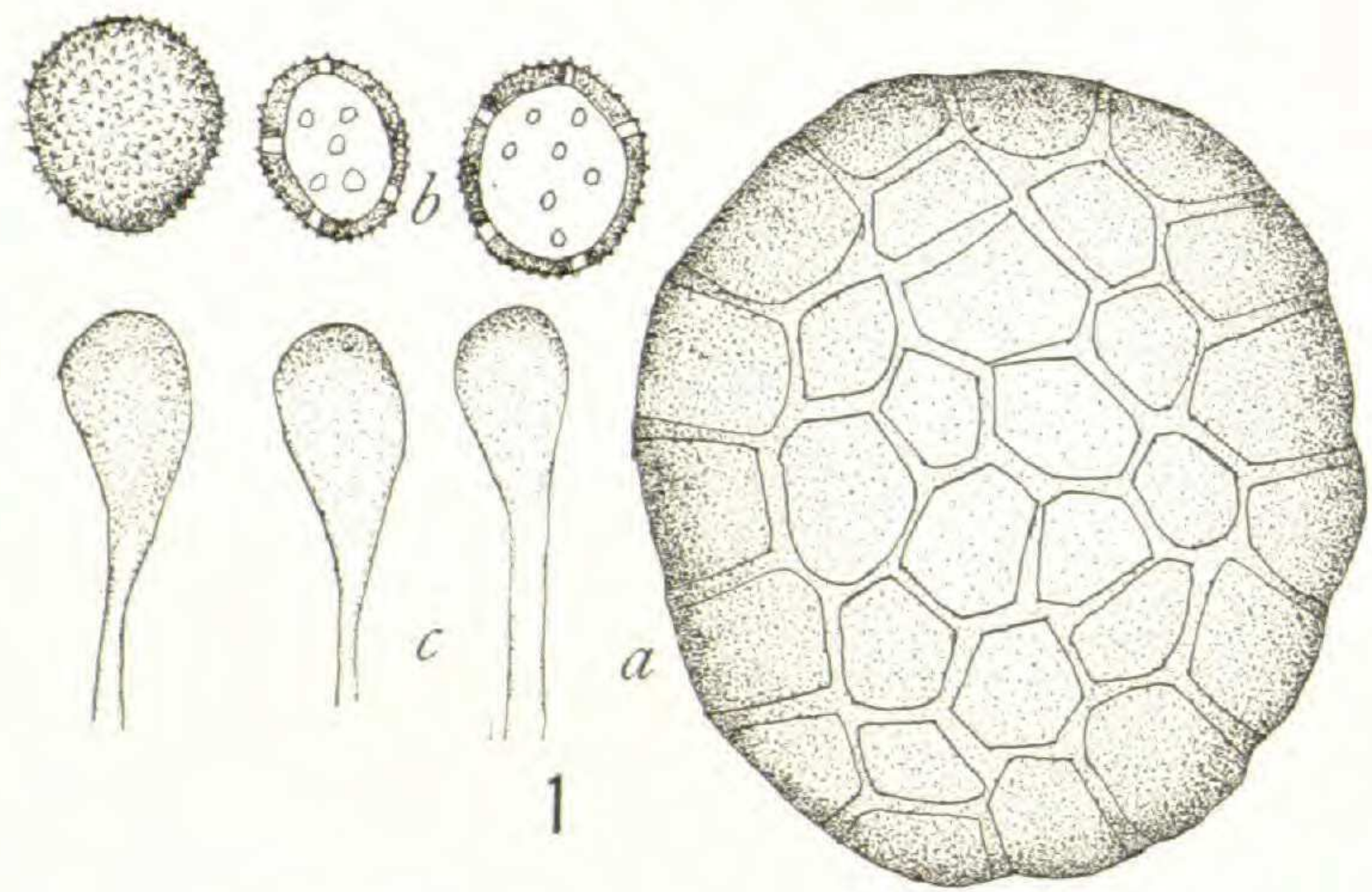
II. Uredosori orbicular to elliptical, averaging 0.3-0.5 mm, sometimes 0.6-0.7 mm in diameter, cinnamon-brown, or chestnut-brown when many paraphyses are present; uredospores oval to obovate to fusiform, 17-24 by 32-45 μ , fulvous, darker and thickened somewhat at the apex, spinulose; germ pores four, equatorial; paraphyses many, capitate; heads intensely dark brown, 15-20 by 20-25 μ ; pedicels stout, hyaline to fulvous, 5 by 20-35 μ .

III. Teleutosori black, scattered, large, 0.75-1-2 mm in diameter; teleutospore heads intensely dark brown, opaque, apex depressed, smooth, 100-150 μ in diameter; 6-10 spores in cross section, each spore 15-20 by 40-45 μ , apex intensely brown for 12-14 μ , remainder of spore semi-hyaline; cysts hyaline, many, beneath the entire head, pendent, ovate to spheroid, swelling and bursting in water; pedicel hyaline, compound, or of separate hyphae, short, deciduous.

On *Prosopis juliflora*: Austin, Texas, May 8, 1901, no. 909 (type of aecidial stage); Aug. 26, 1901, no. 1031 (type for II and III); July 2, 1900, no. 25; Oct. 25, 1900, no. 10; Denton, Texas, June 12, 1902 (I), and Oct. 20, 1902 (III); College Station, Texas, July-Aug. (II), 1888, leg. *Pammel*; Texarkana, Texas, Nov. 5, 1899 (III), *Holway*; San Bernardino, Cal.; leg. *S. B. Parish*, no. 2541 (type of *R. Holwayi* Diet.).

The galls appear soon after the leaves are expanded. In about two weeks the aecidiosori began to open; the galls persist on the trees for several weeks and then usually fall off. They are followed in about two weeks by the uredosori which do not form galls. The uredospore stage continues till October, when the teleutospores begin to appear and these continue till frost kills the leaves of the host.

The rust usually infests trees that are in a low, damp situation, as on the margin of a stream or in a ravine. The "caps" usually appear before the galls and seem to be confined to the leaflets, while the galls are on the leaf stems and young branches.



W.H.L.

LONG on RAVENELIA